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FORECAST GUIDES USED FOR THE CENTRALIZED TERMINAL FORECAST PROG--ETC(U)
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FORECAST GUIDES

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USED FOR THE

CENTRALIZED TERMINAL FORECAST PROGRAM

BY

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[redacted] ARTHUR T. SAFFORD, [redacted]

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UNITED STATES AIR FORCE
AIR WEATHER SERVICE (MAC)
AIR FORCE GLOBAL WEATHER CENTRAL
OFFUTT AFB NEB 68113

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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

William D. Brockmeyer

WILLIAM D. BROCKMEYER, Colonel, USAF
Chief, Aerospace Sciences Division

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Forecast Guides contain an organized discussion of the synoptic weather types that occur in the U.S., a regional description of the synoptic effects, and an individual station breakdown of the local differences in these effects. This information is compiled as a training pamphlet for new forecasters at Air Force Global Weather Central. An extensive knowledge of the local effects at each station is necessary for successful forecasting from a centralized facility. This document is being published

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cont

for use by other Air Weather Service units as a training aid.

This publication is divided into three chapters. The reference material in the first chapter provides information on the upper air patterns and the surface frontal movements for a number of synoptic situations that are common in the Continental United States (CONUS). The regional description in the second chapter divides the CONUS into fourteen similar response areas. The regional effects are discussed in detail for each synoptic type. The individual station Forecast Guides in the third chapter provide a detailed description of each station and its local effects. This provides the forecaster guidance for ceiling and visibility categories under specific synoptic situations. Forecast rules for each station are included in this latter chapter.

PREFACE

In the Centralized Terminal Forecast Program (CTFP), AFGWC has classically been forced to use one forecaster on two COMET regions. Although there are occasional exceptions, the normal workload for an individual forecaster is an average of 25 stations. It is impossible for one man to digest 25 Terminal Forecast Reference Notebooks, and it is equally difficult to keep all these files up to date. In an attempt to incorporate local effects into the essential areal type of forecasting done in the CONUS Products Section, the Terminal Forecast Reference Notebooks are broken down into a) items that require constant review and b) items that require only seasonal review. Synoptic forecasting, local forecast problems with emphasis on terrain, rules-of-thumb and operational units supported make up the backbone of the Forecast Guides. The primary portions of the TFRN labeled as "Climatology" and "Local Forecast Studies" require only seasonal review by forecasters and are split off in separate files.

To provide better reference material and much faster access, a standardized synoptic typing scheme is used for the whole CTFP and kept as simple as possible to increase the level of forecaster understanding. In effect, this eliminates the understandable problem of neighboring CTFP stations which refer to synoptic climatology in diverse ways in their TFRN oriented more to the weather station mission than to macro-scale meteorology. To keep a viable learning curve for the CTFP and Base Weather Stations, it will be necessary to review and add new forecast information to these studies as it becomes available. The Forecast Guides are written with Base Weather Stations very much in mind with the goal of "individualizing" and tailoring the CTFP to each station in a point rather than an areal sense. The Forecast Guide concept may be new, but little of the material contained in these studies is original. This is an operational response to an operational forecasting problem. Besides emphasizing the need for study, the Forecasting Guides provide no magic solutions. Systematic review is necessary by AFGWC and field units on a continuing basis to prevent the rapid fall of synoptic expertise Air Weather Service wide. Revisions to this material must be done regularly based on field and AFGWC recommendations. All forecasters should strive to make the CTFP as believable and mission sensitive as the meteorological state-of-the-art will allow.

Major Arthur T. Safford III

EDITOR'S NOTE.

The Forecasters' Guides are a by-product of the Centralized Terminal Forecast Program (CTFP). They were designed as a training aid that is used to familiarize new forecasters and as a review mechanism.

The initial writing of these guides started in the fall of 1973. The data for each station were extracted from the station TFRNs on hand at AFGWC and forecaster experiences. In 1975, when all the information was compiled, individual copies were sent to each station for review. The feedback from this review was provided to Major Safford at Air Command and Staff College (ACSC) so he could complete the project as part of his ACSC Research Study. A final review and edit of this publication was completed in Oct 76, three years after the start.

A large amount of work by various individuals has contributed to this publication. Special appreciation goes to Capt John R. Bemis, who conceived the idea and drafted the guides for TAF COMET Circuits 41 and 42, Capt Michael C. Holcomb, who assisted Major Safford with half the guides, and the many people who typed and retyped the guides. We also want to thank the forecast units who contributed feedback to the forecast guides so that an improved product could be possible.

There are some advantages and problems with the guides:

1) The pages of Chapter III are numbered by region and individual station so that each unit can be extracted and used separately.

2) This publication provides a finalized working copy for immediate operational use.

3) The editing was held at a minimum in order to expedite publishing this for operational use.

4) The list of units supported (paragraph one of each guide) will be subject to change more than any other part; some of this information might even be out of date at the time of printing.

Significant changes should be forwarded to AFGWC/WPF (e.g., primary customer "Bomb Wing" becomes "Fighter Sq"). Additional changes to the guides that would be beneficial to the CTFP and other using units should be forwarded through the parent organizations to AFGWC and other Wings. Changes will be made within the production unit at AFGWC, but these changes will not be published by AFGWC.

John W. Stryker

JOHN W. STRYKER, Captain, USAF
Asst Chief, Aerospace Services Branch

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*** The pages of each section within the regions are numbered by the station call signes (XXX) and the pages numbered for that station N.**

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STATIONS IN FORECAST GUIDES

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McChord AFB	(TCM)
Fort Lewis - Gray AAF	(GRF)
Fairchild AFB	(SKA)
Mountain Home	(MUO)
Hill AFB	(HIF)
Dugway PG - Michael AAF	(DPG)
Region Two - Central California	
Beale AFB	(BAB)
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Pease AFB (PSM)
Ft. Devens (AYE)

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Camp David (DVD)
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George AFB (VCV)
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Region Ten - Desert Southwest
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Randolph AFB (RND)
Laughlin AFB (DLF)
Ellington AFB (EFD)

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Barksdale AFB	(BAD)
England AFB	(AEX)
Columbus AFB	(CBM)
Keesler AFB	(BIX)
Maxwell AFB	(MXF)
Craig AFB	(SEM)
Ft. Rucker - Cairns AAF	(OZR)
Ft. Benning - Lawson AAF	(LSF)
Eglin AFB	(VPS)
Hurlburt Field	(HRT)
Tyndall AFB	(PAM)

Region Fourteen - South Atlantic Coast & Florida

Pope AFB	(POB)
Seymour-Johnson AFB	(GSB)
Shaw AFB	(SSC)
Myrtle Beach AFB	(MYR)
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Moody AFB	(VAD)
Robins AFB	(WRB)
Dobbins AFB	(MGE)
MacDill AFB	(MCF)
Patrick AFB	(COF)
Homestead AFB	(HST)

Table II

Weather categories used in this Report

A	$= 0, < 200$ ft	or $= 0, < \frac{1}{2}$ mi
B	$\geq 200, < 1000$	$\geq \frac{1}{2}, < 1$
C	$\geq 1000, < 3000$	$\geq 1, < 3$
D	$\geq 3000, < 10000$	$\geq 3, < 6$
E	≥ 10000	≥ 6

CHAPTER I

CONUS SYNOPTIC TYPE DESCRIPTIONS

(Introduction)

For the purpose of discussion, the synoptic types are applicable to all stations in the CONUS. The six basic types are discussed in detail as well as the sub-types which apply to specific cases primarily on both coasts. Sub-types are really not necessary in the central third of the country, because variations in the weather within a given type are generally rare.

WINTER

a. Type A: (See Figure 1). This is known in the Forecast Guides as the "Alberta Low" type. In the upper air, a broad Alaska block exists at 65°N at or near 147°W. One jet circles this ridge from Siberia to Alberta merging or appearing to merge with the main polar jet of mid-latitudes. Under the block is an extremely well developed trough which extends all the way to Hawaii. Its position is variable from day to day as strong minor troughs move up its leading edge into British Columbia. This pattern is extremely stable and once established, can last for weeks. In response to the deep trough off the West Coast, a ridge of moderate amplitude exists over the western U.S. with a downstream trough of the same amplitude near 80°W. A relatively large but not especially deep Hudson Bay low exists. On the surface, chains of frontal waves six or seven in a row crash into the British Columbia and Washington-Oregon coasts giving that area some of its worst weather. The vigorous fronts tend to go aloft over the "Polar Basin" (PB) air of the interior and later the cold arctic air on the east side of the Rockies. As the low aloft starts down from the top of the ridge, a very strong low is induced in the lee-side trough, and an Alberta Low is formed. The track of this low is generally through the southern Great Lakes and up the St. Lawrence River. The parent upper air low remains stationary off the British Columbia coast, and the Pacific Ridge builds into southern Oregon prior to the next surface wave. The Basin High is only of moderate intensity. As the Alberta Low tracks through the Northern Plains, a portion of the Great Basin High does not break off and follow the low.

(1) On the West Coast, fronts stagnate before reaching the California coast. A rather warm modified mP high lies in the Great Basin. This pattern is a classical fog and stratus regime in the Central Valley of California. Some middle cloudiness can be expected to reach the outer coast of California.

(2) The series of occlusions that enter the Pacific Northwest or British Columbia tend to flatten out the ridge aloft. Strong winds aloft combined with warm air advection up a narrow

wedge along the foothills of the Rockies form a lee-side trough all the way from Colorado to northern Alberta. The pattern of development of Alberta Lows is quite varied, but essentially strong height falls combined with overrunning of cA or cP air by moist mP air can cause explosive cyclogenesis. The resulting circulation works upward from the surface and may dig deeply into the basically zonal current over the ridge. These lows will go through the occlusion process and pass through the Great Lakes. Note also the following:

(a) Surface: Waves normally track through the Dakotas, Great Lakes and up the St. Lawrence looking very much like Type E as they move through the Northeast. Very strong arctic outbreaks which move southeastward across Minnesota may follow Type A.

(b) Upper Air: The deep trough in the Gulf of Alaska reminiscent of Type A is usually capped by a ridge in Alaska which has a tendency to block into the Yukon yielding sufficient subsidence for a very strong surface high to form. There are many examples of possible upper air patterns for Type A, but basically look for moderate ridging over the Rockies with confluent flow somewhere around the Great Lakes.

(3) In the eastern third of the country and especially east of the southern and central Appalachians, Type A looks exactly like Type B. In the Northeast, Type A looks like either Type E or Type B. (Not, however, Type B_1).

b. <u>Type A_1</u>: (See Figure 2). This type is a degeneration of the Type A whereby the trough off the West Coast deepens and progresses eastward. (Think of the Type A as being depressed 10^{o} southward). As the main surface low moves into Washington with the parent occlusion, a new wave forms at the triple point and moves into California between 35^{o}N and 42^{o}N. The Basin High cell weakens and moves eastward. The upper air configuration is the same as Type A except the polar jet lies at 38^{o}N.

c. <u>Type B</u>: (See figure 3). Whereas Type A is strictly a winter type, Type B can occur during all seasons. The main difference is that A is a high amplitude type and B is a zonal type. There is no Alaskan blocking ridge. Instead, the block may exist over Siberia or the North Pole. There is a definite lack of high latitude jets. There is a rather strong low in the Gulf of Alaska with another low along the Aleutian Islands. The associated trough is broad but of very low amplitude. The polar jet is generally weaker and lies along the Canadian Border. The ridge over the western U.S. has low amplitude aloft, but with the Pacific Ridge strong at the surface, the amplitude of the ridge aloft varies greatly from day to day. A weak trough exists downstream at 75^{o}W with the Hudson Bay Low over Labrador and deeper than in Type A.

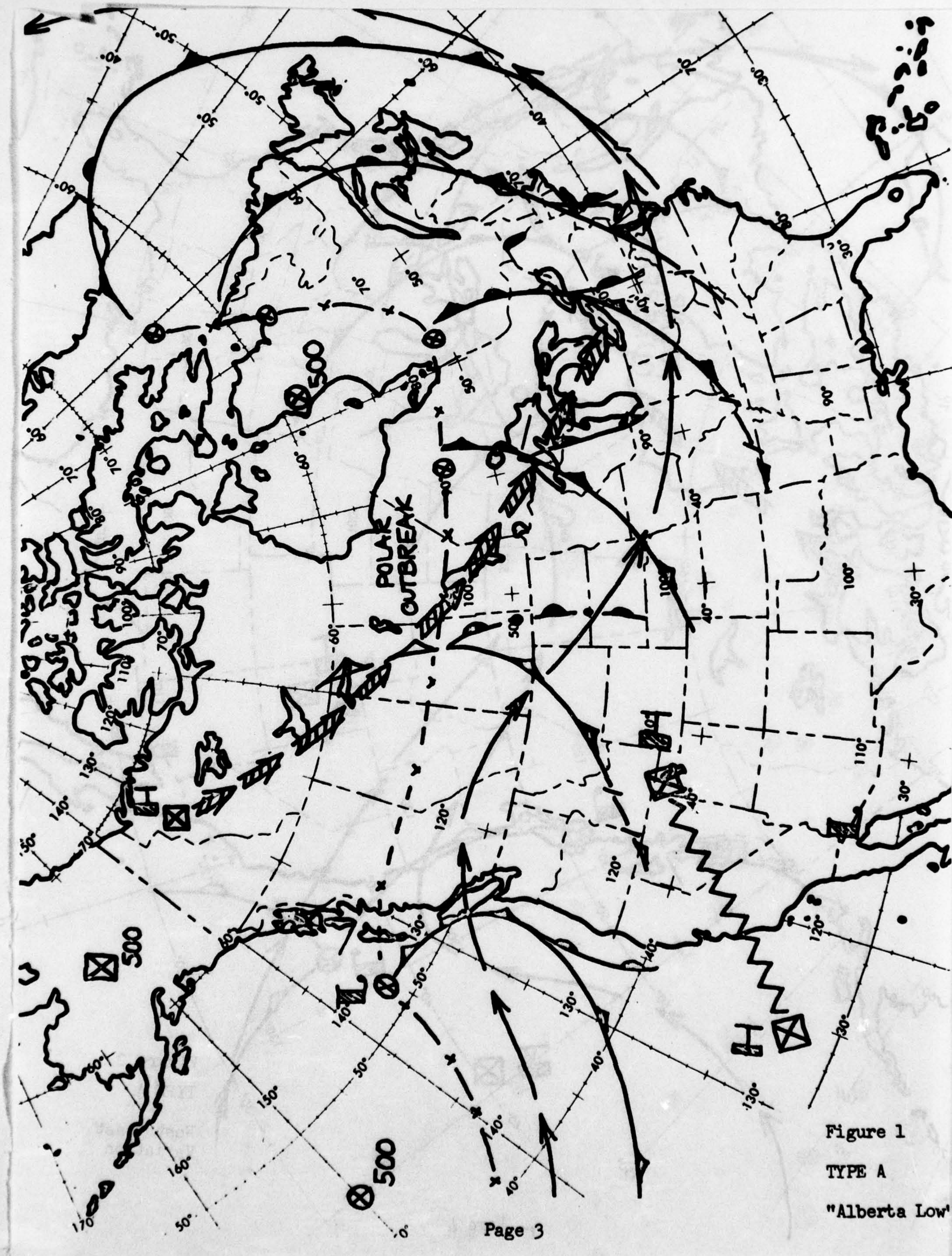


Figure 1

TYPE A

"Alberta Low"

Figure 2
TYPE A_1
West Coast Variation

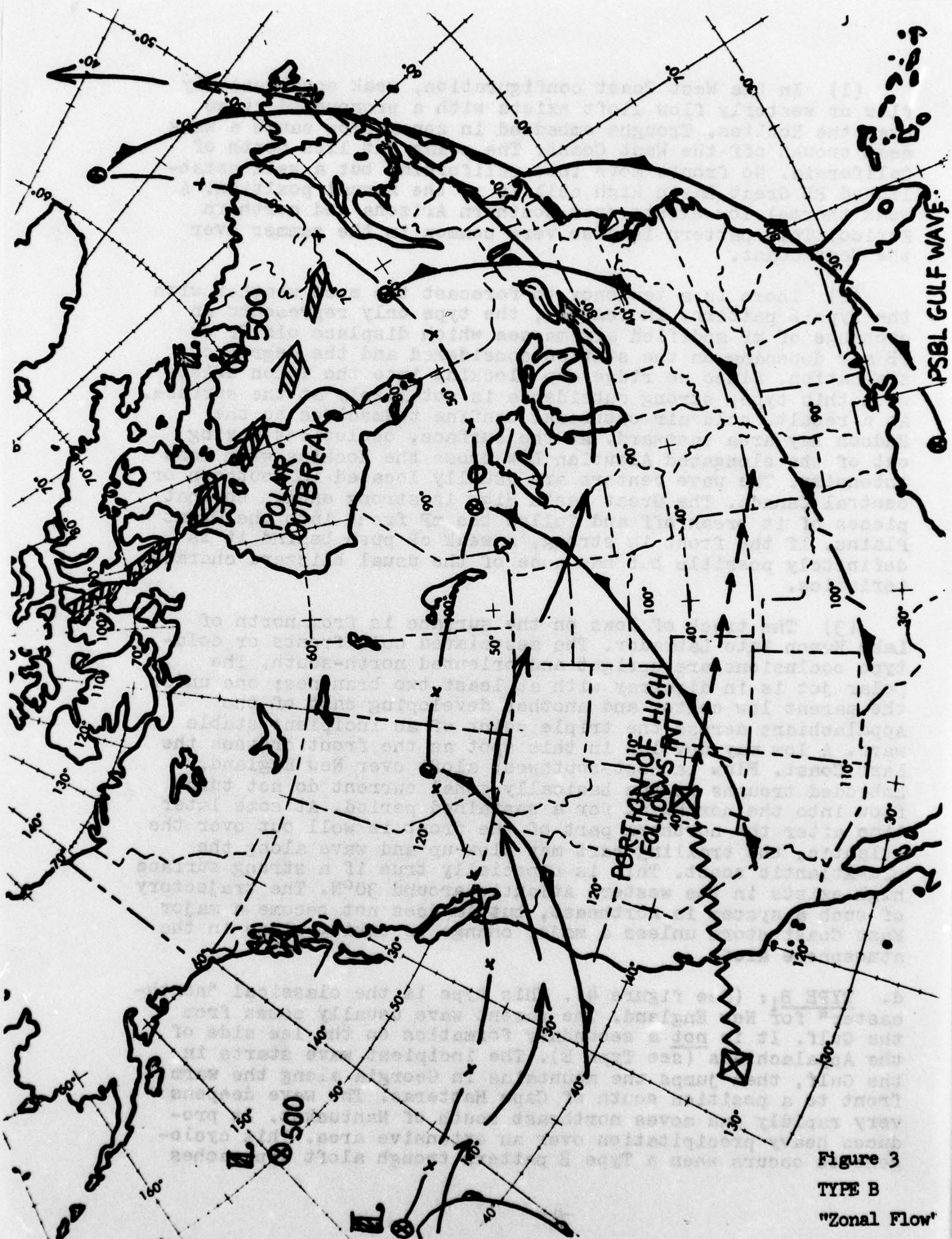


Figure 3

TYPE B

"Zonal Flow"

(1) In the West Coast configuration, weak southwesterly flow or westerly flow aloft exists with a pronounced ridge over the Rockies. Troughs embedded in zonal flow cause a weak mean trough off the West Coast. The polar jet lies north of California. No fronts move into California, but a well established PB Great Basin High cell is in the normal position. A weak thermal low exists over southern Arizona and northern Mexico. This pattern is also very common in the summer over the West Coast.

(2) There is a tendency to forecast too much weather with the Type B pattern. In reality, the type only represents an exchange of mP modified air masses which displace old CP or PB air depending on the station considered and the degree of stagnation. Since no ridge cap blocking into the Yukon exists with this type, strong subsidence is not likely at the surface. As a result, cold air outbreaks confine themselves to the Hudson Bay area eastward. At the surface, occlusions moving out of the elongated Aleutian Low cross the Rockies with less intensity. The wave centers are usually located in southern or central Canada. The Great Basin High is strong enough so that pieces of it break off and follow the mP front into the Great Plains. If the front is strong, a weak cP push behind it is definitely possible but has none of the usual blizzard characteristics.

(3) The track of lows on the surface is from north of Lake Huron into Labrador. The associated cold fronts or cold-type occlusions are upright and oriented north-south. The polar jet is in disarray with at least two branches; one under the parent low center and another developing east of the Appalachians across the triple point of an incipient stable wave. A low may develop in this spot as the front crosses the East Coast. Flow is west-southwest aloft over New England. Embedded troughs in the basically zonal current do not turn flow into the northwest for a sustained period. At some later time after the northern part of the front is well out over the Atlantic, the trailing part may slow up and wave along the mid-Atlantic coast. This is especially true if a strong surface high exists in the western Atlantic around 30°N. The trajectory of such a system is northeast, but it does not become a major East Coast storm unless a major change is taking place in the atmosphere aloft.

d. <u>TYPE B_1</u>: (See figure 4). This type is the classical "northeaster" for New England. The parent wave usually comes from the Gulf. It is <u>not</u> a secondary formation on the lee side of the Appalachians (see Type E). The incipient wave starts in the Gulf, then jumps the mountains in Georgia along the warm front to a position south of Cape Hatteras. The wave deepens very rapidly and moves northeast south of Nantucket. It produces heavy precipitation over an extensive area. This cyclogenesis occurs when a Type B pattern trough aloft approaches

Figure 4

TYPE B_1

Common East Coast Variety

West Coast Variation

the East Coast with somewhat more strength in the southern Mississippi Valley. At the same time, a major change in the atmospheric pattern takes place, allowing a new major trough position to form near the East Coast. The progression of the upper long wave causes a very strong baroclinic zone to form and explosive development as cold air moving off the continent comes in contact with tropical Gulf Stream air. The jet aloft develops from lower levels upward causing a deep trough to form and sometimes closing off as high as 200 mb. The actual track of the low is very difficult to forecast and requires very careful analysis.

(1) The zonal configuration is depressed far enough south so that a strong southwesterly polar jet exists over northern California. Troughs cross the West Coast and ride over the ridge in the Rockies. It is not unusual for a closed pool of cold air to exist in the trough as it traverses California. Expect a rather strong cold or cold-type occluded front with this system. Normally, this type will only exist for one or two troughs crossing the West Coast before the type degenerates into something else.

e. <u>Type B_2</u>: (See figure 5) A zonal configuration exists across the Pacific Ocean between 36°N and 42°N similar to the Types B and B_1. The main difference lies in the increased amplitude of the ridge over the Rockies and Great Plains. Not only is the ridge stronger but also has a longer wavelength. (Think of the Type B depressed far southward). The Aleutian Low is split with the eastern lobe in the southern Gulf of Alaska. The polar jet crosses the West Coast at 40°N. Occluded fronts or open waves cross in a series from the west. The first one may look like Type A_1, then that one is followed by low centers which move inland south of 40°N. Deepening of waves occurs in the mean trough off the West Coast. The Great Basin High is either non-existent or depressed into the Desert Southwest.

(1) On the East Coast, B_2 is the converse of B_1. Instead, the trough along the West Coast progresses inland and deepens somewhat toward the southeast. Ridging increases a little over the upper Mississippi allowing troughs to slip under into the Southeast. The so-called "Panhandle Stable Wave" forms and moves directly eastward. The flow aloft, however, is confluent over the East Coast and no deepening takes place until the low reaches the water off Cape Hatteras. The wave will then begin to recurve but stays sufficiently away from the coast to prevent precipitation at Air Force installations. The primary forecast problem is that this configuration is quite common and is often mistaken for the Hatteras Low. The jet aloft lies across Connecticut with a secondary moving across the Southeast. The direction of flow is west to west-northwest. A surface high is present over the Great Lakes region. Weather in the Northeast is good.

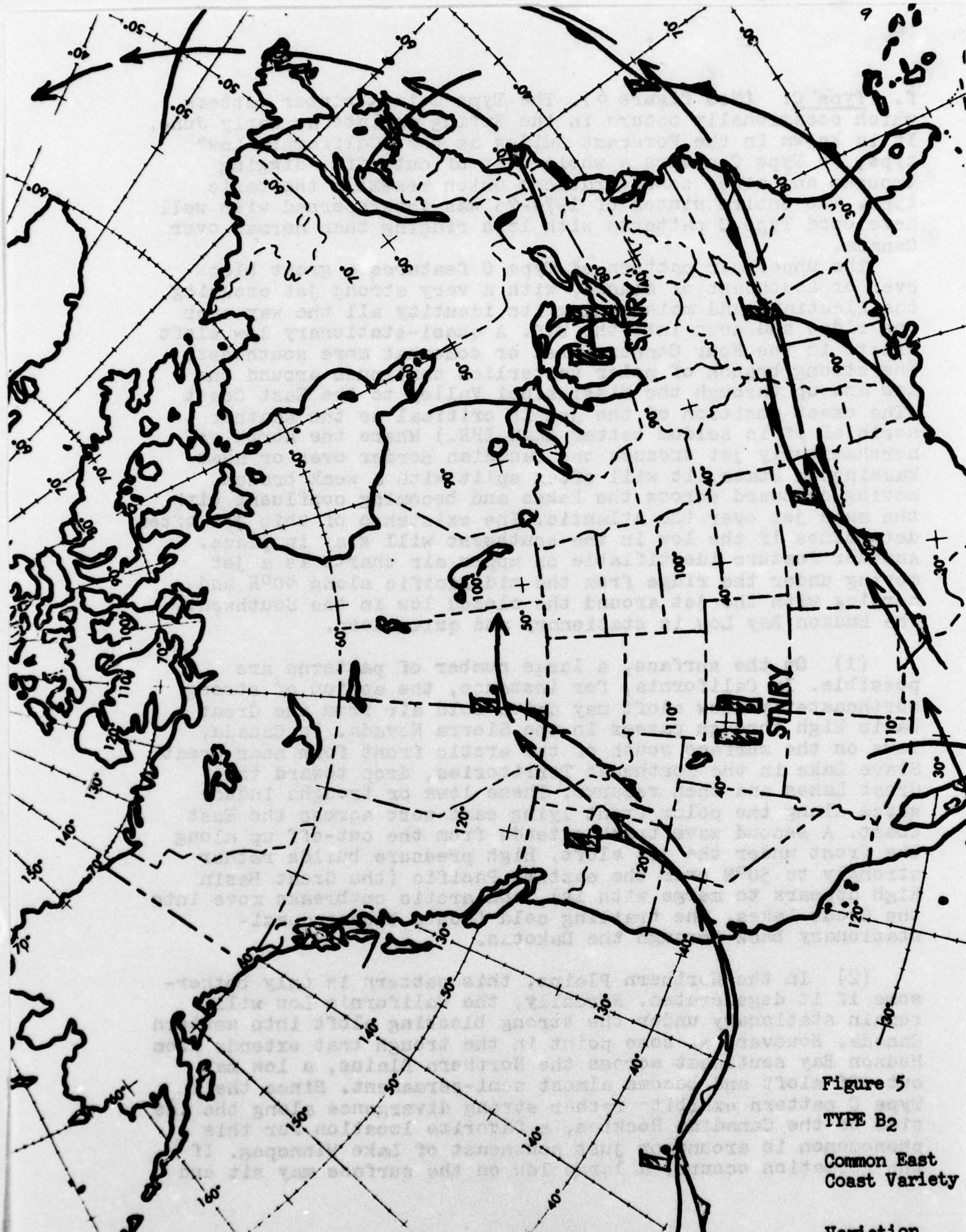


Figure 5

TYPE B_2

Common East Coast Variety

Variation West Coast

Type B_2

f. <u>Type C</u>: (See figure 6). The Type C is a winter pattern which occasionally occurs in the Spring as late as early June. It is known in the Forecast Guides as the "California Low" type, as Type C covers a whole host of cut-offs, digging troughs and other configurations which resemble the basic type. The entire winter of 1974-75 was interspersed with well developed Type C patterns with less ridging than normal over Canada.

The upper air pattern of Type C features a great block over or southeast of Alaska, with a very strong jet crossing the Aleutians and maintaining its identity all the way over the ridge and down into the U.S. A quasi-stationary low aloft exists in the Four Corners area or somewhat more southwest. The strong branch of polar westerlies continues around the low and up through the Mississippi Valley to the East Coast. (The exact position of the jet is critical as the weather north of it is seldom better than IFR.) Where the north or northeasterly jet crosses the Canadian Border over or near Washington State, it will often split with a weak branch moving eastward across the Lakes and becoming confluent with the main jet over the Atlantic. The existence of this jet often determines if the low in the southwest will stay in place. Another feature identifiable on upper air charts is a jet moving under the ridge from the mid-Pacific along 40°N and merging with the jet around the closed low in the Southwest. The Hudson Bay Low is stationary and quite deep.

(1) On the surface, a large number of patterns are possible. In California, for instance, the action of strong northeasterly flow aloft may drive cold air from the Great Basin High through passes in the Sierra Nevada. In Canada, lows on the surface south of the arctic front form near Great Slave Lake in the Northwest Territories, drop toward the Great Lakes and then recurve. These lows or troughs induce waves along the polar front lying east-west across the East Coast. A second wave track extends from the cut-off up along the front under the jet aloft. High pressure builds rather strongly to 50°N over the eastern Pacific (the Great Basin High appears to merge with it), and arctic outbreaks move into the Great Lakes. The trailing cold fronts become quasi-stationary back through the Dakotas.

(2) In the Northern Plains, this pattern is only bothersome if it degenerates. Normally, the California Low will remain stationary under the strong blocking aloft into western Canada. However, at some point in the trough that extends from Hudson Bay southwest across the Northern Plains, a low may cut off aloft and become almost semi-permanent. Since the Type C pattern exhibits rather strong divergence along the lee side of the Canadian Rockies, a favorite location for this phenomenon is around or just southeast of Lake Winnepeg. If the formation occurs, a large low on the surface may sit and

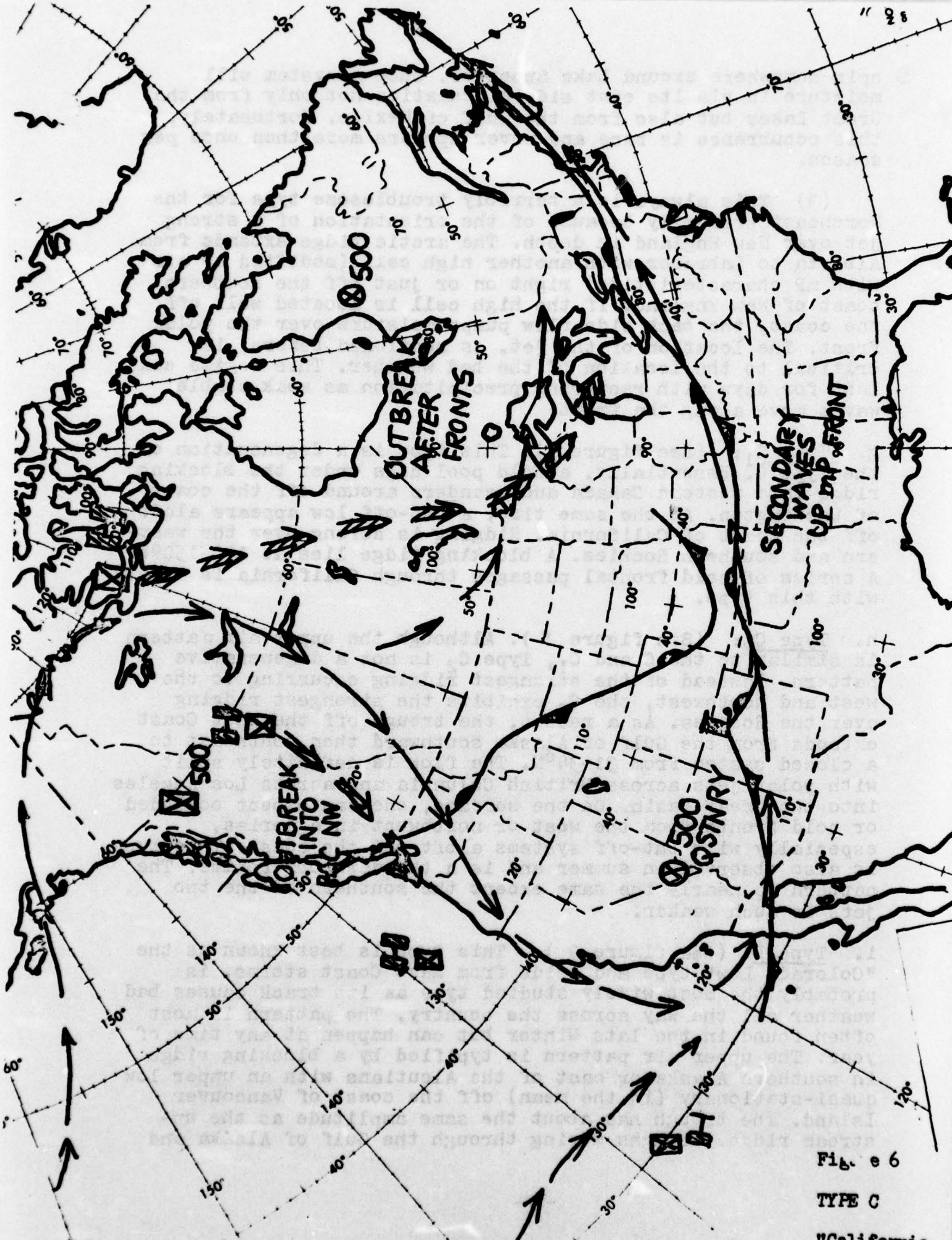


Figure 6

TYPE C

"California Low"

spin somewhere around Lake Superior. Such a system will moisture in via its east side circulation not only from the Great Lakes but also from the Gulf of Mexico. Fortunately, this occurrence is rare and never appears more than once per season.

(3) This always is a terribly troublesome type for the Northeast primarily because of the orientation of a strong jet over New England in depth. The arctic ridge extends from Alberta to Labrador with another high cell (modified cP air with mP characteristics) right on or just off the southern coast of New England. If the high cell is located well off the coast, the back side flow pumps moisture over the polar front. The location of the jet, as mentioned before, is critical to the location of the bad weather. This regime can last for days with recurring precipitation as weak stable waves move along the front.

g. Type C_1: (See figure 7). This type is a degeneration of the Type C. Essentially, a cold pool digs under the blocking ridge into western Canada and meanders around off the coast of Washington. At the same time, a cut-off low appears aloft off the coast of California. Ridging is strong over the western and southern Rockies. A blocking ridge lies at 140-150°W. A series of cold frontal passages through California is likely with this type.

h. Type C_2: (See figure 8). Although the upper air pattern is similar to the C and C_1, Type C_2 is not a degenerative pattern. Instead of the strongest ridging occurring to the west and northwest, the C_2 exhibits the strongest ridging over the Rockies. As a result, the trough off the West Coast extends from the Gulf of Alaska southward then southeast to a closed system from 31-34°N. The flow is definitely split with polar jets across British Columbia and across Los Angeles into the Great Basin. On the surface, one can expect occluded or cold fronts from the west or northwest in a series, especially with cut-off systems aloft off the coast. This type is also observed in summer and is a thunderstorm regime. The pattern is nearly the same except the southern of the two jets is much weaker.

i. Type D: (See figure 9). This type is best known as the "Colorado Low" type and aside from East Coast storms, is probably the most widely studied type as its track causes bad weather all the way across the country. The pattern is most often found in the late Winter but can happen at any time of year. The upper air pattern is typified by a blocking ridge in southern Alaska or east of the Aleutians with an upper low quasi-stationary (in the mean) off the coast of Vancouver Island. The trough has about the same amplitude as the upstream ridge. Troughs moving through the Gulf of Alaska and

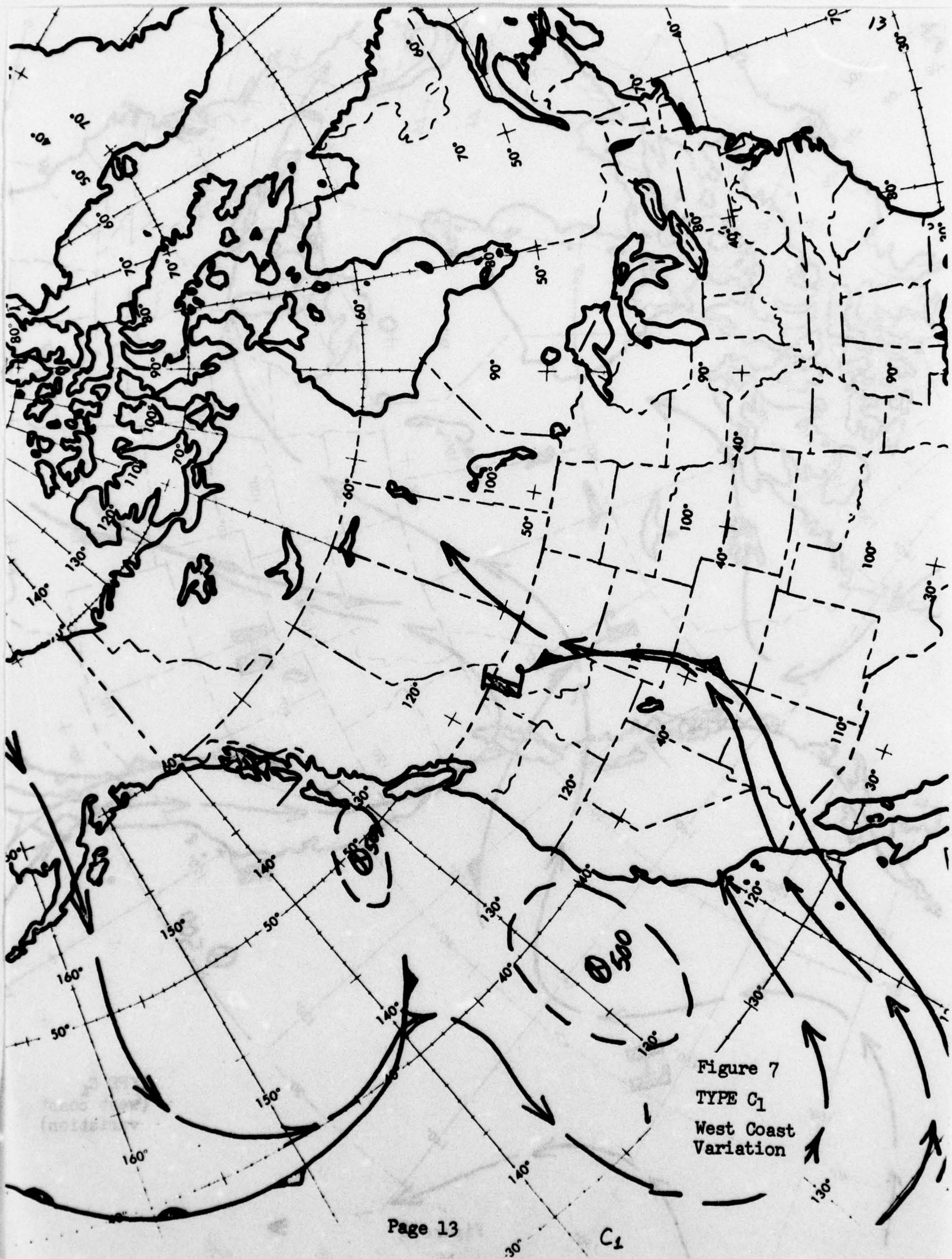


Figure 7
TYPE C_1
West Coast
Variation

C_1

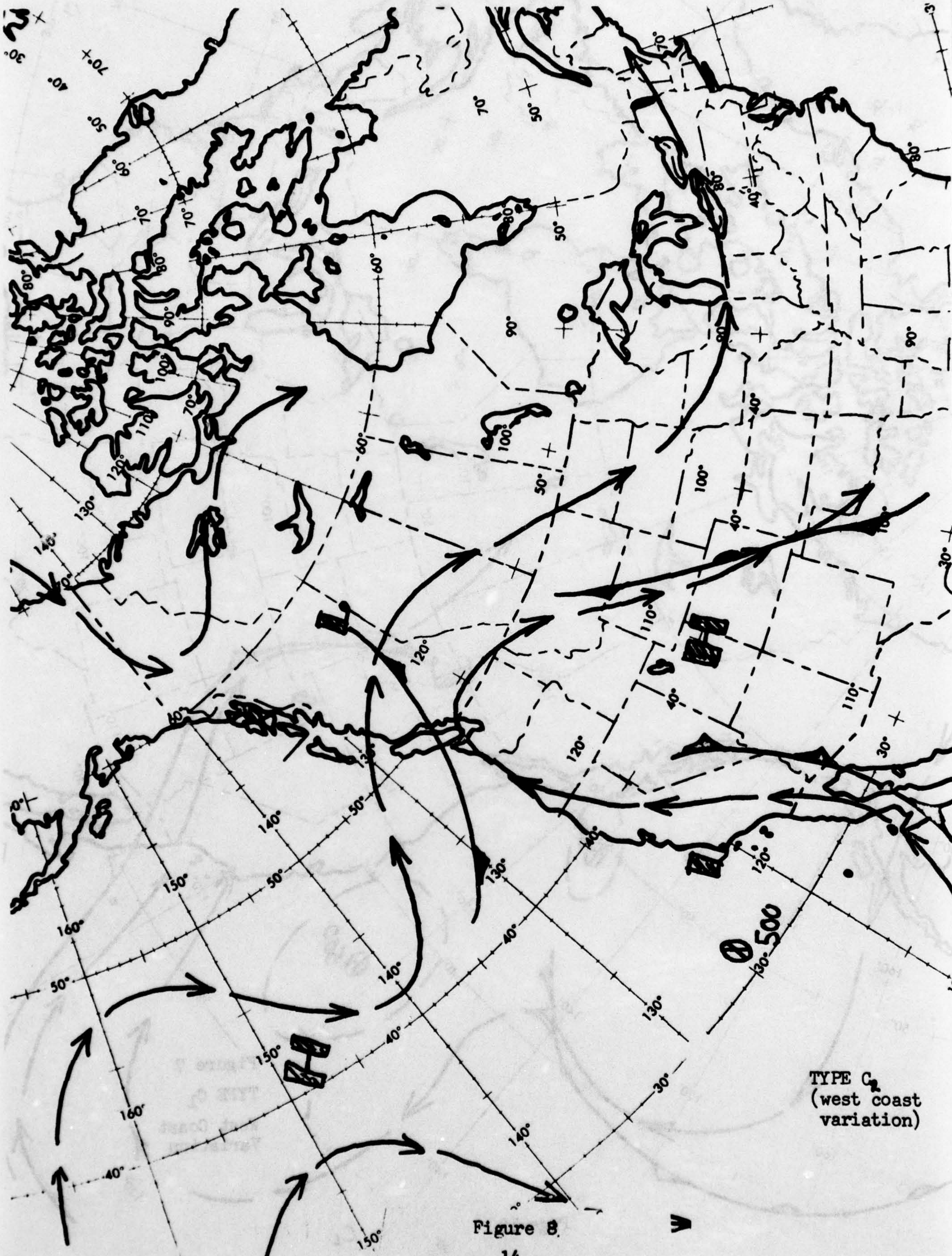


Figure 8

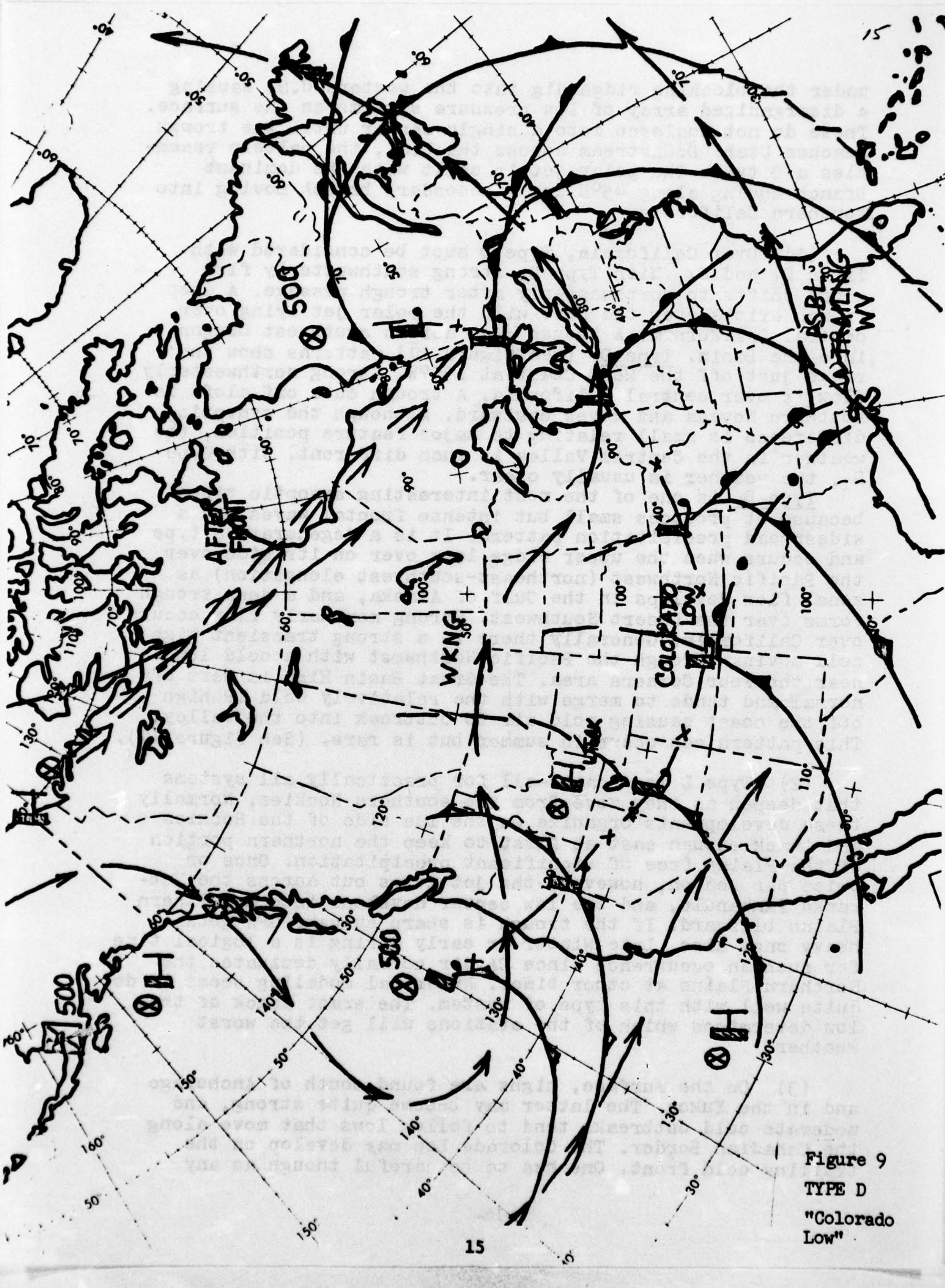


Figure 9
TYPE D
"Colorado Low"

under the blocking ridge dig into the western U.S. causing a disorganized array of low pressure systems on the surface. These do not coalesce into a single center until the trough reaches Utah. Downstream across the U.S., the pattern resembles a B type. The polar jet is split with the dominant branch moving along 45°N and a secondary branch moving into southern California.

(1) Over California, Type D must be considered with Types D_1 and D_A. With Type D, strong southwesterly flow aloft shifts to northwesterly after trough passage. A deep trough exists over the West with the polar jet lying over central California. A trough digs across southwest Oregon into the Basin. Type D_1 (see figure 10) patterns show the ridge just off the West Coast at 135°W. Strong northwesterly flow is over central California. A trough cuts off aloft in southern Nevada and moves eastward. Although the synoptic difference is small relating to major feature position, the weather in the Central Valley is much different. With Type D_1, the weather is usually clear.

Type D_A is one of the most interesting synoptic types because it produces small but intense frontal waves and a widespread precipitation pattern. It is a degenerative type and occurs when the upper ridge lays over on its side over the Pacific Northwest (northeast-southwest elongation) as zonal flow develops in the Gulf of Alaska, and a deep trough forms over the Desert Southwest. Strong northerly flow occurs over California. Generally there is a strong transient high cell moving through the Pacific Northwest with a cold low near the Four Corners area. The Great Basin High is west of normal and tends to merge with the relatively cold mP high off the coast causing cold air to outbreak into the Valley. This pattern can occur in summer but is rare. (See figure 11).

(2) Type D is a catch-all for practically all systems that deepen as they move from the southern Rockies. Normally these developments organize on the lee side of the Rockies and track enough east at first to keep the northern portion of the Plains free of significant precipitation. Once or twice per season, however, the jet moves out across the Nebraska Panhandle, and the low center develops into a Northern Plains blizzard. If the trough is sharp enough, GFA gets heavy snow also. Late Winter or early Spring is a logical time for such an occurrence since CA air normally dominates the Northern Plains at other times. Numerical modeling seems to do quite well with this type of system. The exact track of the low determines which of the stations will get the worst weather.

(3) On the surface, highs are found south of Anchorage and in the Yukon. The latter may become quite strong, and moderate cold outbreaks tend to follow lows that move along the Canadian Border. The Colorado Low may develop on the trailing cold front. One has to be careful though as any

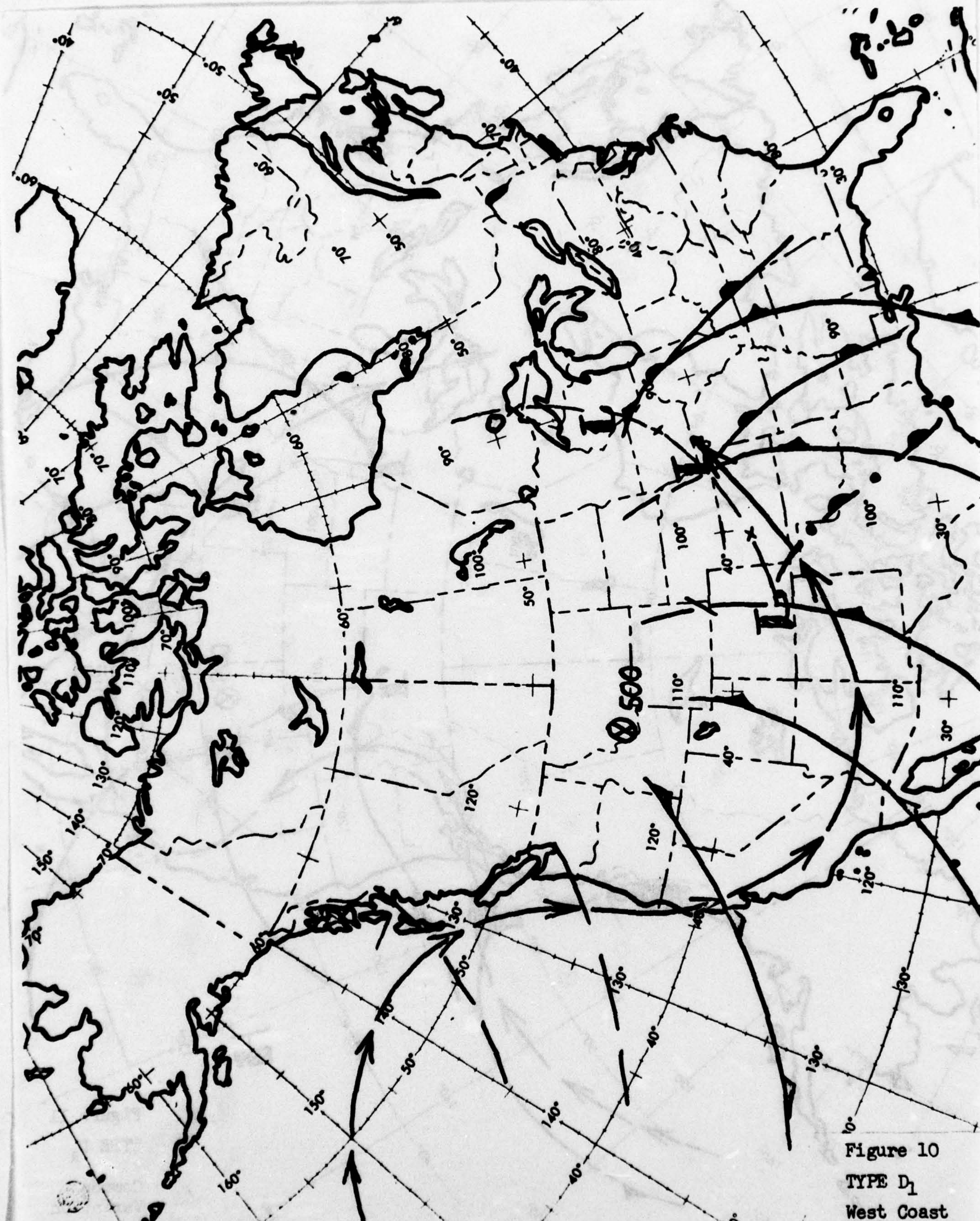


Figure 10

TYPE D_1

West Coast Variation

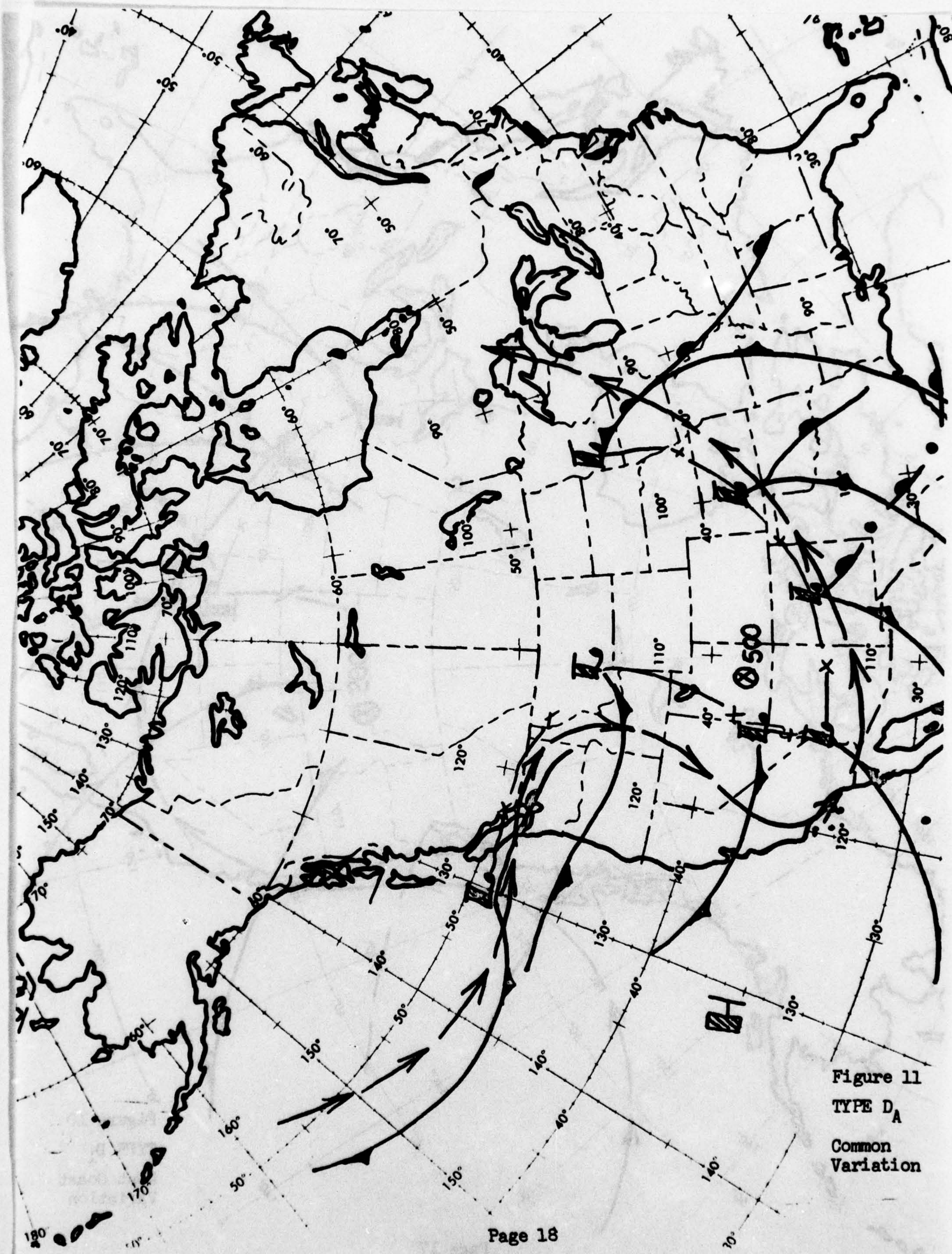


Figure 11
TYPE D_A
Common Variation

weakness (with time) in the jet moving through southern California or in the trough moving through the Inter-mountain Region will cause the D type pattern to degenerate to a B. Assuming the Colorado Low develops, the Central Plains will be heavily affected depending on the path of the storm. Type D is a severe weather producer as well, since the storm track is typically across the Mississippi into Illinois with a strong tendency to recurve. The length of time available for Gulf moisture to reach the Central Plains determines the amount of precipitation that will occur. One key to watch for is the formation of some kind of low in southeast Texas or in the Gulf which will effectively cut off the moisture supply to the Central Plains. Numerical prognostic tools handle the development of Colorado Lows well, but the primary problem is the track.

(4) Surface systems with the Type D can follow two tracks; one across the northern Rockies and the second from Colorado as just discussed. Both tracks recurve sharply over the Great Lakes, although the Colorado Low prefers Lake Huron and Lake Erie. Both types cause deep warm-type occlusions which cause heavy snow from northern Iowa to Upper Michigan.

(5) Ahead of the deepening low moving out of the Plains, ridging on the surface and aloft strengthens along the Appalachians into Ontario and Quebec. As the winds aloft increase over southern Michigan and Ohio, the surface high moves sluggishly over into New England. The weather will remain favorable in the Northeast until the warm occlusion works its way into western New York State. The forecaster should also watch out for low clouds developing in coastal areas as the strong modified high cell moves out over the Atlantic.

j. <u>Type E</u>: (See figure 12). The Type E is the most common atmospheric type in North America and is the one most similar to climatology for the winter months of the year. The type is important to the Northeast and poses a significant forecasting problem. A Gulf Low moves up the west side of the Appalachians, or a low develops in the Southern Plains and takes a similar path. Although a wave will probably appear on the warm front near Washington, D.C., development is unlikely. Assuming no wave develops on the lee side, New England experiences typical warm front overrunning with an extended period of bad weather. If a strong trough aloft is supporting the system on the surface, progression of the long wave will likely cause the otherwise stable wave on the lee side to develop. The most important decision then is to determine which surface low will dominate; the low in the Ohio Valley or the incipient wave off the Virginia-Maryland coast. Most historical sources seem to indicate that if a high cell is sitting over northern New England or a ridge extends from Labrador to northern Michigan, that the low in Ohio will dissipate when it reaches the Lakes and allow the coastal wave to take over. If the high cell sits off the coast, the lee side wave will be blocked out allowing the occluded wave to continue northeastward up the St. Lawrence

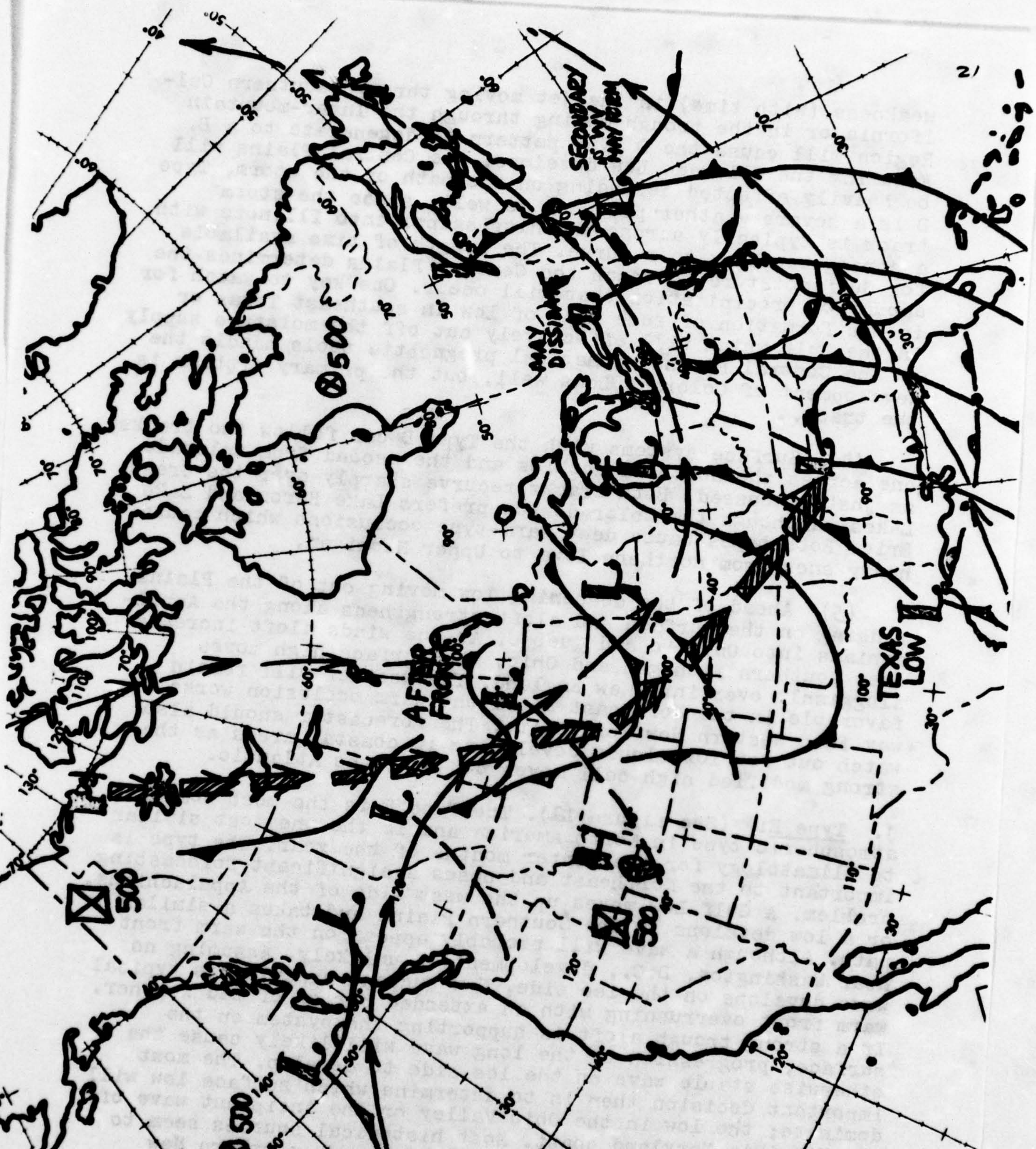


Figure 12

TYPE E

"Texas Low"

and the front to cross over New England. The key is to closely examine and prog the upper wind flow.

(1) The Type E is also known as the "Texas Low" type. The upper air pattern generally shows a solid ridge (no split flow into southern California) all the way from Baja to 70°N and sometimes all the way to the North Pole. A trough exists in the western Gulf of Alaska, but fronts emanating from this location usually stay north of Washington State. The trough just west of the Appalachians is strong and tends to retrograde when systems cross the Rockies over the ridge. This causes strong baroclinicity to exist in east Texas or in the Gulf which will assist rapid development of a surface wave. Arctic outbreaks behind these troughs move southeastward into the Plains behind the deepening surface low. The Type E pattern occurs at all times of the year. If it occurs in the summer, below normal temperatures are experienced over much of the eastern half of the U.S. The Texas Low is not likely to form, but cold fronts running down the front side of the ridge will trigger copious thunderstorm activity.

(2) In California, this type causes little weather. As mentioned, a strong ridge lies over the West Coast or slightly east of that point. The Pacific High is well north of normal in Winter with a weak thermal low apparent in the Desert Southwest or northern Mexico. Flow is westerly aloft and weak. In the summer, the thermal trough becomes quite strong and moves into the Central Valley. Type E_1 (See figure 13) is another degenerative type which occurs between D_1 and E systems or vice versa. E_1 shows a ridge aloft with a slight tilt northeast-southwest from southern British Columbia to 30°N 135°W. Northerly flow aloft exists over California.

k. Type E_s: (See figure 14). Type E rapidly turns into Type E_s when the ridge over the West Coast suddenly takes on increased amplitude and blocks into the Yukon. Type E_s is known as the "Gulf Wave" type and is the only hybrid type considered to affect the entire country. E_s differs from E in that a closed low aloft exists in southern California under the blocking ridge. This low, however, may be connected to another trough out in the mid-Pacific or be open to broad troughing over the East Coast. On occasion, it will become totally disconnected from the main westerlies and remain in place for days. In split flow which always occurs with this type, the northern branch of the polar jet is stronger than the southern branch which may actually be a reflection of the higher altitude sub-tropical jet. When in existence, the area from southern California to west Texas and further east into the Gulf is adversely affected. As systems aloft pass through Texas, they spawn waves on old mP or modified cP fronts lying stationary in the Gulf States or over the water. The waves tend to remain stable and move due eastward. It is possible for the jet flow to be interrupted over the Gulf of Mexico at times eliminating the chance of significant Gulf waves.

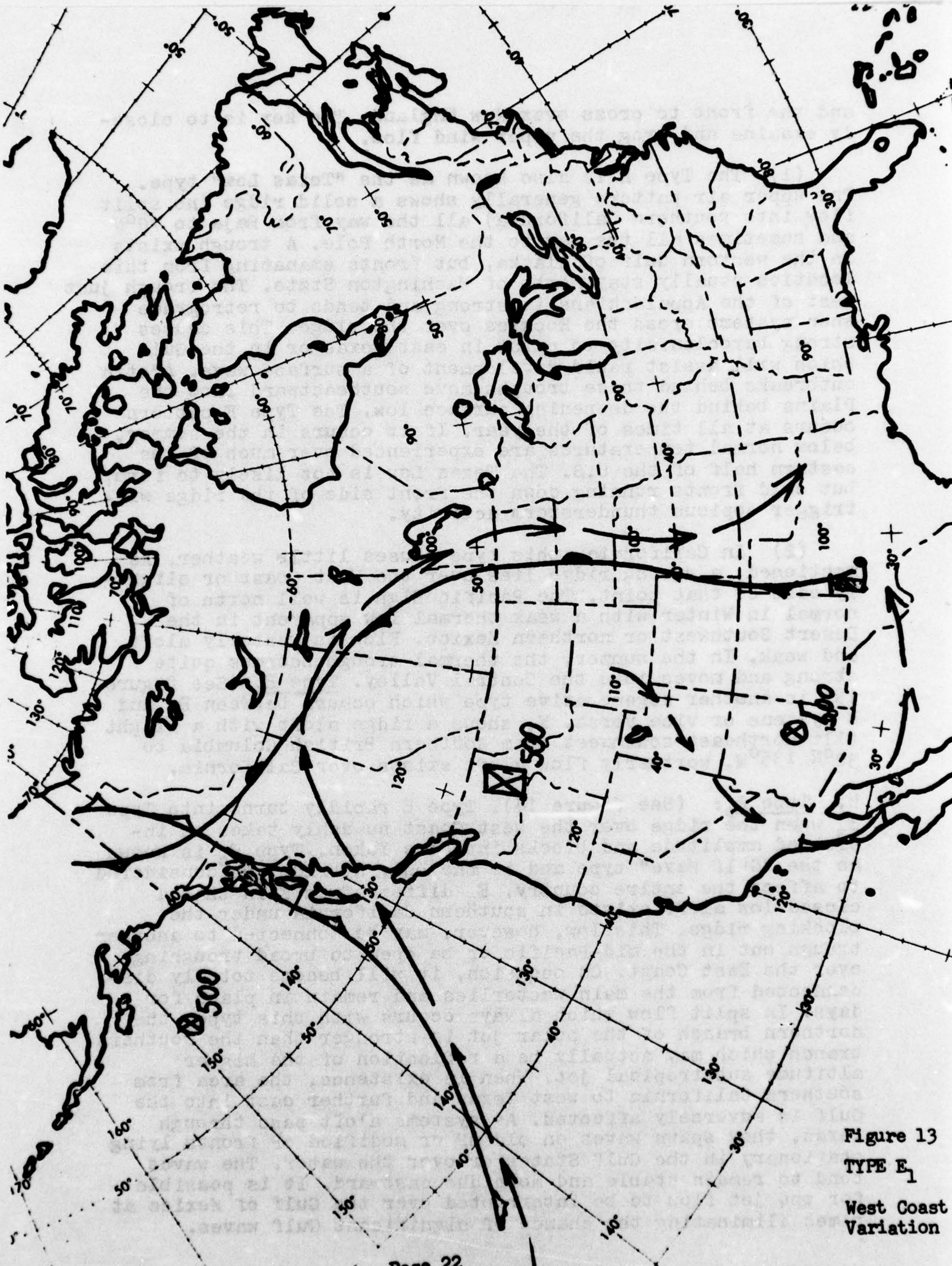


Figure 13

TYPE E_1

West Coast Variation

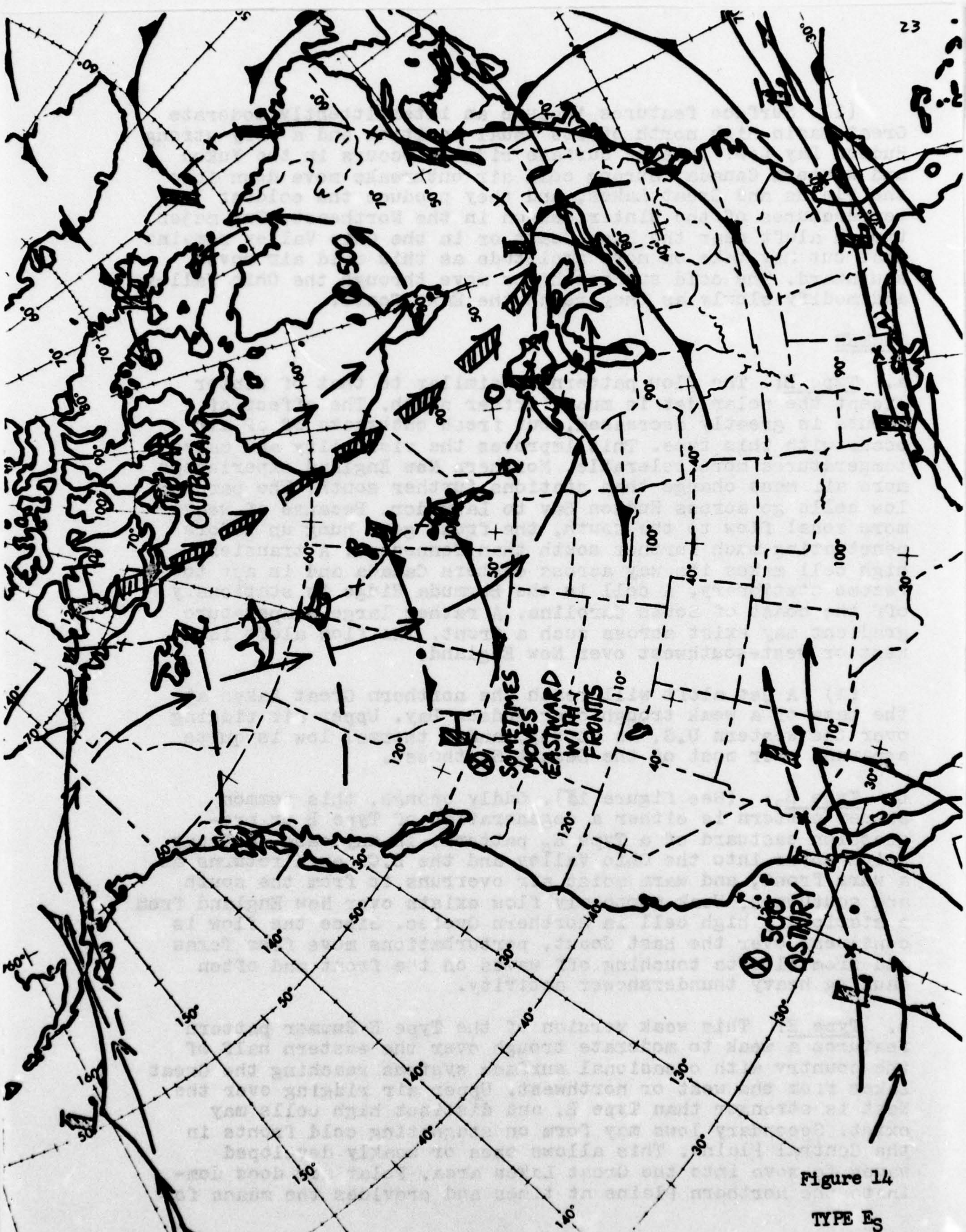


Figure 14

TYPE E_S

Gulf Wave

(1) Surface features include an intermittently moderate Great Basin High north of its usual position and a very strong Hudson Bay Low. Intense surface ridging occurs in the Yukon and western Canada. Strong cold air outbreaks move down into the Plains and Great Lakes, and they produce the coldest temperatures of the Winter season in the Northeast. The major trough aloft near the East Coast or in the Ohio Valley remains flat but may take on more amplitude as this cold air moves southward. The cold surface highs move through the Ohio Valley and modify slowly as they reach the East Coast.

<u>SUMMER</u>

a. <u>Type B</u>: The flow pattern is similar to that of Winter except the polar jet is much further north. The effect of fronts is greatly decreased, but fresh outbreaks of cP air occur with this type. This improves the visibility and makes temperatures more tolerable. Northern New England experiences more air mass change than stations further south. The parent low cells go across Hudson Bay to Labrador. Because of weaker more zonal flow to the south, the front gets hung up before penetrating much further south than Tennessee. A transient high cell makes its way across eastern Canada and is apt to become stationary. A cell in the Bermuda Ridge is stationary off the coast of South Carolina. A rather large temperature gradient may exist across such a front. The flow aloft is west or west-southwest over New England.

(1) A jet aloft will reach the northern Great Lakes at the base of a weak trough over Hudson Bay. Upper air ridging over the western U.S. is strong, and a thermal low is quite apparent over most of the Desert Southwest.

b. <u>Type B_3</u>: (See figure 15). Oddly enough, this common Summer pattern is either a degeneration of Type B or progression eastward of a Type E_s pattern. In any case, a front which moves into the Ohio Valley and the D.C. area returns as a warm front, and warm moist air overruns it from the south and southwest. Weak northerly flow exists over New England from a stationary high cell in northern Quebec. Since the flow is confluent over the East Coast, perturbations move from Texas and from Alberta touching off waves on the front and often causing heavy thundershower activity.

c. <u>Type E</u>: This weak version of the Type E Summer pattern features a weak to moderate trough over the eastern half of the country with occasional surface systems reaching the Great Lakes from the west or northwest. Upper air ridging over the West is stronger than Type B, and distinct high cells may exist. Secondary lows may form on stagnating cold fronts in the Central Plains. This allows open or weakly developed waves to move into the Great Lakes area. Polar air does dominate the Northern Plains at times and provides the means for

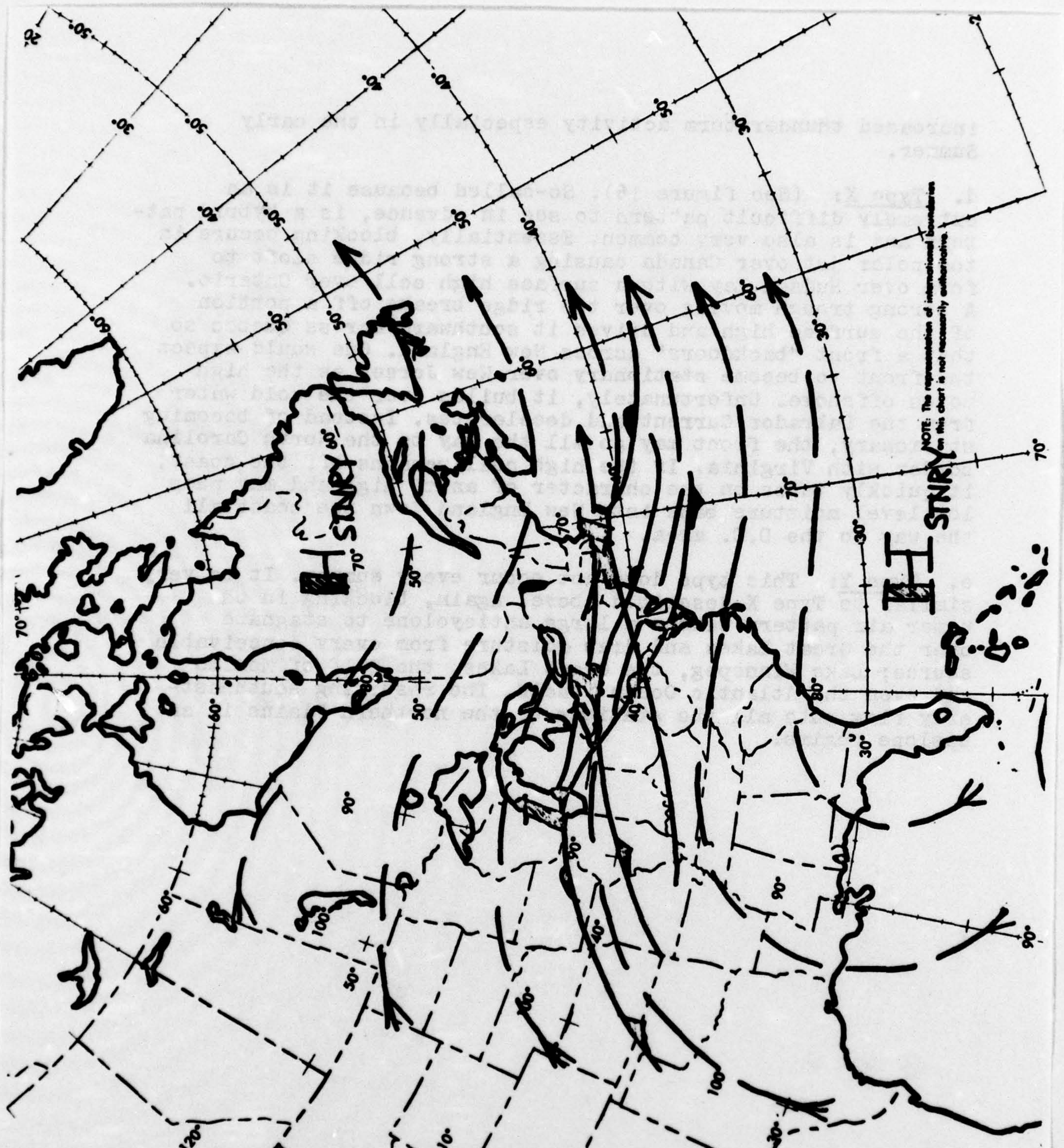


Figure 15
TYPE B_2
Summer
East Coast
Variation

increased thunderstorm activity especially in the early Summer.

d. Type X: (See figure 16). So-called because it is an extremely difficult pattern to see in advance, is a hybrid pattern and is also very common. Essentially, blocking occurs in the polar jet over Canada causing a strong ridge aloft to form over Hudson Bay with a surface high cell over Ontario. A strong trough moving over the ridge breaks off a portion of the surface high and drives it southward across Quebec so that a front "backdoors" across New England. One would expect the front to become stationary over New Jersey as the high moves offshore. Unfortunately, it builds over the cold water from the Labrador Current and decelerates. Instead of becoming stationary, the front may go all the way to the North Carolina border with Virginia. If the high cell remains off the coast, it quickly takes on the character of an mP high and may pump low level moisture back into New England down the coast all the way to the D.C. area.

e. Type Y: This type does not occur every Summer. It is very similar to Type X described above. Again, blocking in the upper air pattern causes a large anticyclone to stagnate over the Great Lakes and draw moisture from every conceivable source; Lake Winnepeg, the Great Lakes, the Gulf of Mexico and even the Atlantic Ocean itself. The resulting southeasterly flow puts all the stations of the northern Plains in an upslope regime.

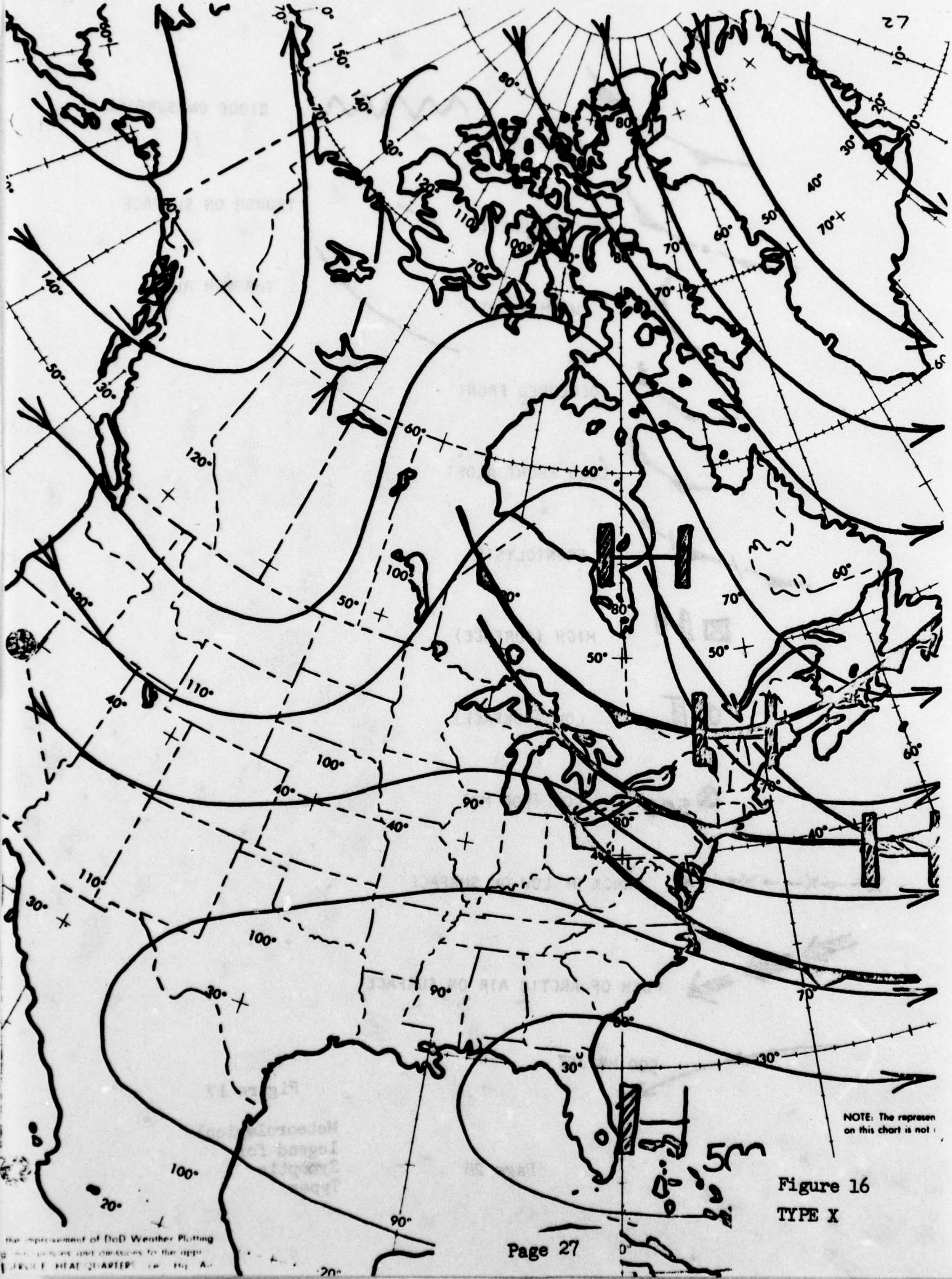


Figure 16
TYPE X

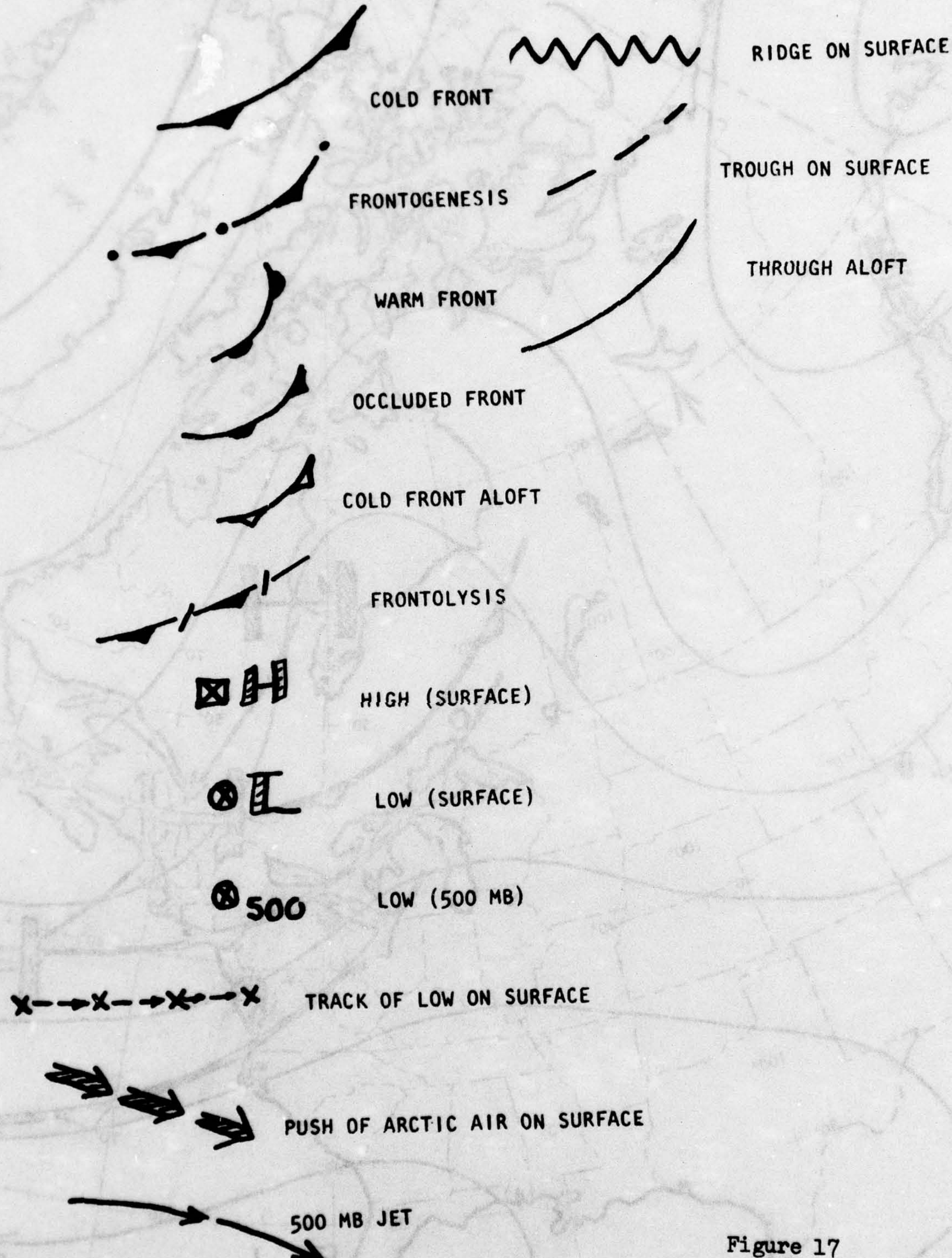


Figure 17

Meteorological legend for Synoptic Types

CHAPTER II

REGIONAL SYNOPTIC DISCUSSIONS

(Introduction)

REGION 1

Region 1 (Pacific Northwest) experiences as many synoptic regimes as there are stations and has the dubious distinction of different terrain types at each location. Micro-terrains in themselves do not create the weather but cause very large deviations in macroscale systems off the Pacific Ocean when compared to an essentially flat maritime polar climate like England or the Benelux Countries.

Unlike most stations in the United States, McChord and Gray Field are affected by two semi-permanent features: the Pacific High dominating in Summer, the Aleutian Low in Winter. In Summer, the Pacific High is in place off the Pacific Northwest coast all the time and makes occasional penetrations into the mainland. The ridgeline, however, often lies north of Puget Sound giving an off-shore component to the surface wind. In winter, storms forming along the southern periphery of the Aleutian Low cause most of the frontal systems that cross the Washington coast. Strong off-shore flow is apt to precede these systems and on-shore flow after. The intensity and positioning of the Aleutian Low is the sole determining factor in forecasting both the strength of systems and associated weather which moves through the stations. At Fairchild, the effects of these systems is different. Summer is characterized by very little frontal weather with the strong Pacific High offshore and a thermal trough in the Columbia Basin. Frontal passages are weak, although gusty winds and thunderstorms pose short range forecasting problems. During Fall, there is a transition to more frequent frontal passages in the mean with decreasing thunderstorm activity as the return of the polar jet and retreat of the thermal trough happen simultaneously.

Synoptically speaking, the intensity of a front crossing the Cascades will determine what will happen at both Mountain Home and Fairchild, but a strong Columbia Basin High can provide different weather conditions with the same front, especially at MUO. Forecasters refer to mP (maritime polar air) that modifies in the MUO area as PB (Polar Basin). This is a semi-dry air mass which is cooled primarily by nighttime radiation as it stagnates. Stagnation of the mP air mass in the Summer inevitably results in the cT hot and dry situation. Fresh outbreaks of cP air across the Continental Divide only occur once a year on the average. Frontal discontinuities and troughs are much more intense in winter than in summer as the jet stream moves southward. Mean storm tracks pass close to MUO in the winter as waves form on triple points of old occlusions passing over the Cascades aloft and reforming over the Columbia Basin under divergent

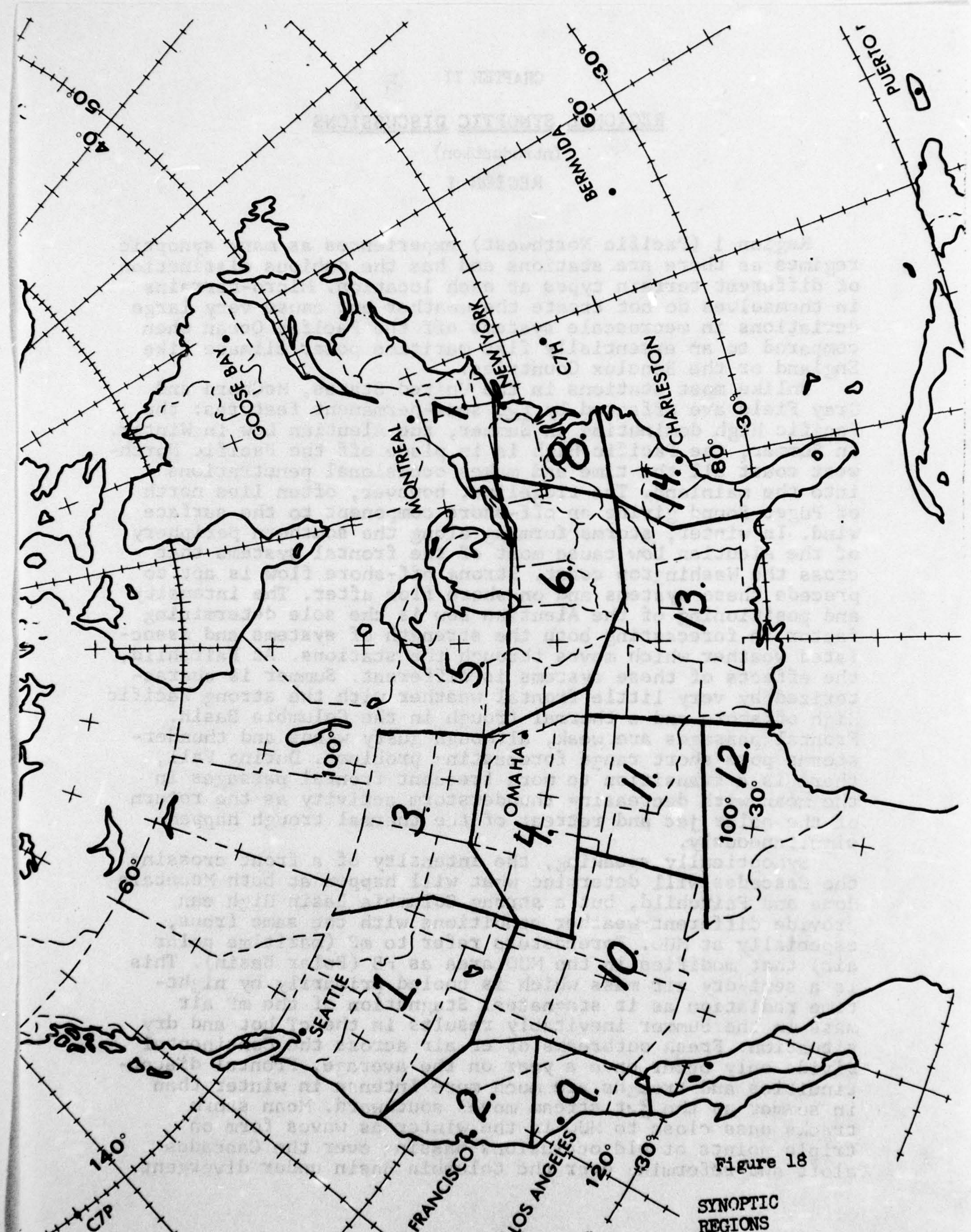


Figure 18

SYNOPTIC REGIONS

flow aloft. Strong winds, rapid shifting and abrupt weather changes characterize MUO frontal weather. In March through May and September through November, these fronts appear to pass on the surface. In winter, however, the mP air mass has a tendency to ride up over the PB or modified CP air over the area.

The Pacific Ridge plays less of a role at Hill and Dugway Proving Ground. The intensity of the thermal low in summer is only a determining factor in the amount of moisture which is pulled off the Gulf of Mexico. Subsidence in the mean does occur in this area as well as at MUO, primarily as the result of ridging aloft rather than subsidence from the Pacific High. The orientation of strong fronts off the Pacific is different than for MUO or SKA. The position of the major trough in the central U.S. is very important. Keep in mind that orographic influences are as (if not more) important than synoptic influences in this area.

REGION 2

Central California could be best described as being a Mediterranean climate with cool damp winters in contrast to rather hot and dry summers. The weather is generally clear in the summer with most of the irregularly spaced rainfall periods occurring in the winter when the greater portion of about 20 inches of rain occurs. The dominant synoptic controls for the valley area are the same as for the Pacific Northwest and the Intermountain stations ; namely the Aleutian Low, Pacific High, and Great Basin High. The relative locations of these major features control the intrusion of the four major air masses which affect the area. In general air masses approaching from the north through southeast are continental in origin or modified mP which undergo warming and drying in the strong descent over mountain ranges. Maritime air masses approaching the area from a northwest through south-southeast direction have had an ocean trajectory with the flow southwest through south - the warmest water influence. The four air masses are mP, cP, cT, and mT.

Modified (warmed and dried) after moving onshore, mP air dominates the area all year but is especially prevalent during winter. Relatively unstable during winter, it becomes exceptionally stable during summer owing to strong subsidence on the periphery of the Pacific High which reaches its greatest intensity and northward position in the summer. There are occasions when a fresh mP air mass may enter the Valley and stagnate. If at the same time the Great Basin High builds, cP air will spill over and subside on the lee of the Sierra further drying out the inversion top and leading to the well known San Joaquin fog and stratus.

Rarely, a strong outbreak of cP air, originating in western Canada, will reach the Valley. In spite of considerable modification, very low temperatures occur.

From June through September, cT air originating over the California-Sonora Desert may dominate the area for extended periods when the thermal low and trough moves west of the Sierra Nevada. Characteristics of cT air are maximum annual temperatures, very low humidity and clear skies. Occasionally, the Bermuda Ridge (aloft) will extend far enough westward to pump moisture at upper levels into California. The warm moist air overrides the dominant low level mP air and produces copious thundershower activity especially over the mountains. mT air can also come from the Gulf of California and southward of 30°N.

When the Pacific High moves southward in the fall, the northerly circulation down the California coast and around into the thermal low ceases in the mean. This allows an increase in the amount of frontal activity in central California as the Aleutian Low deepens and moves eastward.

Forecast rules for each synoptic type may be found under the individual station. There are at least 25 distinct types which affect central California - mostly degenerative or larger amplitude patterns extending to lower latitudes of the same types which affect the Pacific Northwest. Twelve of these are discussed in the "Synoptic Type Descriptions" and represent the most commonly observed patterns. Fronts are associated with several of these types. The intensity of a front can be subjectively determined from surface information and thickness.

(1) If there are six (four millibar interval) isobars intersecting three 200-foot (60M) thickness lines, then the front is of moderate intensity.

(2) The less the angle and number of intersections, the weaker the front; the more angle and number of intersections, the stronger the front is.

(3) Precipitation will normally start 300 NM before a front reaches the station, but this time can be moved up as much as four hours for a strong one and backed off somewhat for a weak one.

(4) Anticyclonic curvature of isobars behind the front indicates the 700 mb trough will be two to four hours behind with rapid clearing. Cyclonically curved isobars suggest that the upper trough will lag allowing showery precipitation to continue.

In the winter at Ft. Ord, the presence of the Aleutian Low and a flatter gradient in the mean cause much more erratic surface mean flow than in the summer. In general, however, land-sea flow (continental) is observed in lieu of a major system. In the summer, air mass interactions are simpler. The Pacific High and thermal low combination produce

strong onshore flow in the mean.

The action of modifying low level mP air is perhaps the most interesting effect. As polar air moves around the Pacific High, it is warmed and picks up moisture from the Ocean. The moisture is usually present in the lower 1500 feet and can be identified on the OAK (72493) and VBG (72393) soundings. The modified air is condensed as it passes over the southward extension of the cold Kuroshio current. Along this current, upwelling (the forcing of cold water to the surface along the Continental Shelf) occurs which contributes to the formation of fog and stratus on a nearly daily basis. This fog and stratus normally occurs in cycles of three to seven days as follows:

(1) Development of a thermal low pulls the stratus (which forms offshore) inland resulting in sudden onset of low ceilings.

(2) End of the cycle is characterized by the dissipation of the low clouds gradually.

a. A ridge develops in the Great Basin and weakens the thermal trough producing a land breeze along the coast and/or;

b. A thick marine layer develops up to 2,000 and 2,500 feet which then spills into the Valley lowering the surface temperature gradient between the Valley and the Coast resulting in a weaker westerly component in the mean.

REGION 3

The Northern Plains area is probably the most difficult area to categorize synoptically since most of the weather regimes discussed in the introduction simply do not produce extended periods of difficult forecasting at Malmstrom, Grand Forks, Minot and Ellsworth. Instead, surges of arctic air in combination with the common synoptic patterns produce the really severe weather in this area that preclude mission accomplishment. As a result, the synoptic types are treated in the introduction somewhat differently than for the Pacific Northwest or Great Lakes. With zonal patterns, the weather is generally good, while the reverse is true with high amplitude patterns.

Even in winter time, the percentage of time that VFR flying conditions exist is extremely high; somewhere around 80% or more. The major problems are blizzards, extreme chill and severe thunderstorms all of which tend to occur with high amplitude patterns. This area is also a favorite spot for CAT associated with large shears in the lee of the Rockies. In the mean, slight troughing exists at 500 mb over the Great

Lakes with the strongest jet over the Ohio Valley. Secondary jets, sometimes very strong, develop over the Rockies and commonly relate to invasions of fast moving arctic air. Although cP and mP air masses dominate, they can under various circumstances become cA such as:

(1) An extended period of nocturnal cooling when the synoptic pattern is stable.

(2) A rather low sun angle which contributes to negative incidence of solar energy and gives a total negative balance day after day.

(3) Presence of snow cover even if the depth is small.

(4) The natural slope of the land which is generally downhill from west to east at all stations except RDR where cold air tends to collect in the Red River.

An mP front approaches from the west and does not necessarily displace the low level cold air. Unless it is very shallow or prolonged low level warm air advection takes place, the mP front is apt to stay aloft as it passes over the area. In the spring, the upper flow begins to shift northward, and the upper air pattern progresses somewhat with ridging over the Rockies and troughing further east. Lee side troughs are more common under the leading edge of the upper ridge. These are associated with deep lows that form in Montana and move southeastward or that form in Colorado and move northeastward. The change of air masses is almost continuous and can be quite extreme. Precipitation in the mean increases with the greater amount of shower and thundershower activity.

In summer, patterns weaken considerably, and VFR weather reaches 95%. Diffuse and confused upper flow, however, is occasionally convergent in the low levels and divergent at the upper levels over the Plains producing the conditions for severe weather. The primary air mass contrast is fresh mP completely displacing a stagnate cP air mass or mT air mass.

REGION 4

Five of the six basic synoptic types apply to the Central Plains as the sub-types really only apply to both coasts. Because the effects of each are complicated in this area, a separate discussion will be provided for each type. The area covered extends from lee side Colorado to northern Kansas to Missouri, western Iowa and Nebraska. This area, like Loring, lies close to many of the major storm tracks in the country. It comprises, among other things, portions

of tornado alley. The weather is highly variable from year to year, but weather regimes are rather well organized in most seasons.

There are really only three seasonal patterns in the Central Plains. A defined spring pattern rarely appears; the winter pattern going rapidly into a summer pattern. Perhaps it is justified to call it early winter and late winter. The explanation for this rapid transition in mid-April to a summer pattern is the very active storm track through the southern or Central Plains which keeps cloud cover heavy in the mean and temperatures down.

(1) Type A: The Great Basin High is only moderate and so as the Alberta Low tracks through the Northern Plains, a portion of the high does not follow the low. (An arctic air mass may drop into the Great Lakes). There are three forecast problems in the Central Plains with Type A.

a. The moisture content of the air associated with the system.

b. The chances of Gulf moisture returning far enough north to become associated with the surface to 850 mb low.

c. The chances of a strong arctic outbreak occurring behind the Alberta Low.

The answer to (1) can be traced to some extent by doing regular analysis and watching rawin data. Generally speaking, a fair amount of moisture above 10,000 feet will travel over the ridge and survive subsidence on the lee side of the Rockies. As the system develops, category D ceilings will appear along the front with category B or A in the colder air north of the wave.

The answer to (2) is extraordinarily difficult as low level wind fields are poorly forecast. A blanket statement can be made that return flow will not get established with an Alberta Low. As far as Offutt, the Kansas City area, and eastern Colorado is concerned, the statement is 90% true. By the time the low reaches the northern Mississippi Valley, Gulf flow may reach it. A forecaster can answer (3) by making a determination of the central pressure expected in the center of the Alberta Low and the Yukon High. If forecast to be greater than 1040 mb or greater, one would do well to bring a portion of the high south behind a secondary cold front. In early winter, the cold air will pick up moisture in southern Canada and sweep category C strato-cumulus southward. Offutt is the only station that will be affected. Late in the winter, fronts associated with this type are likely to be dry in the Central Plains.

(2) Type B: Type B is a zonal type in contrast to Type A which has high amplitude. As each front crosses the Rockies, a portion of the Great Basin High breaks off and

moves into the Plains. Category D ceilings or low E ceilings accompany the front, but forecasting the height in advance of such a system is almost impossible. The low on the surface tracks through the Northern Plains or southern Canada. In the summer, thunderstorms (possibly severe) will affect the Central Plains. Once the thunderstorm ceilings form, they follow good continuity in a diurnal pattern. With the Type B pattern, there is only one question to answer. Will the Gulf moisture return to the Central Plains before the front arrives?

The answer is not simple. In general, the appearance of a jet aloft across Texas and up the East Coast signals the cut-off of the moisture return from the Gulf to the Plains as ridging builds across the southern Rockies. The appearance of that jet, however, is also a signal that the upper air apparently is shifting. If there is no jet and a stagnant cP or mP high exists in the southeastern states, then forecast the return of Gulf moisture. With Type B, the return of moisture is more common in the summer than in the winter. This applies about equally to all Central Plains stations.

(3) Type C: This type covers a whole host of Southwest U.S. cut-offs with strong flow aloft over the Central Plains. There are many questions to be answered as this type is a real problem to forecast.

a. Will the cut-off come out?

b. Will the moisture axis off the Gulf be over or just east of the Plains?

c. Will arctic air pass any Central Plains stations.

No one has the answer to (1) and especially not computer models. The tendency is for all progs to bring out the low, when in fact they rarely do. About the best one can get is a vorticity maximum, but not until another definite vorticity area is moving into the base of the trough. The whole system will not move out until the upper trough can be forced to take either a direct north-south or a northwest-southeast orientation by a trigger moving eastward into the Gulf of Alaska south of 40^{O}N. Once the upper trough is forced upright, it can move eastward creating a major storm (like Type D) in the process. (See sub-type C_m described for COS and BKF). With Type C, there is moisture all over the place and usually a lot of clouds. Keeping track of the moisture axis is necessary for forecasting the areas of low clouds. One must be very careful with (2) because a well-defined axis right over the Central Plains may move eastward as a major storm develops. As far as (3) is concerned, normally only Offutt gets into the arctic air.

(4) Type D: Assuming the Colorado Low develops, the Central Plains will be heavily affected depending upon the path of the storm. Offutt is the only station which will almost always get snow. The only exception to this occurs when the track of the low is northwest of normal. The storm track is typically across the Mississippi River into Illinois thence into the Great Lakes with a strong tendency to continue recurving toward Hudson Bay. The length of time that Gulf moisture has to penetrate into the Central Plains determines the amount of precipitation which will fall (also the amount of severe weather). One key is to watch for a weak wave forming in east Texas or in the northwest Gulf. Any tendency in that direction will cut off the extensive return of moisture into the Plains. Generally, numerical progs handle the Type D very well, and the primary problem, therefore, is the track.

(5) Type E: Since the E pattern looks most like winter climatology, one would expect this pattern to be quite common. During the winters of 73-74 and 74-75, this was the case. The Kansas City stations are usually right on the edge of the precipitation shield, so the time of storm organization from incipient to well-developed becomes critical. Keep in mind that the track of this low is from Texas to the St. Lawrence River.

REGION 5

Despite the six classifications of major synoptic types described in the introduction, there is only one fundamental pattern over the Great Lakes, one of troughing under the Hudson Bay vortex. All frontal chains begin with an initial system from the west or northwest and then followed by some type of secondary. Most systems deepen as they approach and recurve toward the northeast as they occlude. The Great Lakes themselves are air mass modifiers by taking the edge off of temperature extremes and adding moisture to the air.

It is not helpful to offer statistical data on the frequency of domination by different synoptic types, because identifications can become controversial and types do vary considerably in frequency from month to month and year to year. Nevertheless, five very general surface patterns are recognizable, and smoothed data is offered here by season. The statistical reference used is the Map Type Catalog for the Great Lakes Window based on 25 years of data (1946-71) and prepared by the 3rd Weather Wing. Intervals are as follows:

Winter:	**November to March**	**Summer:**	**June to August**
Spring:	**April and May**	**Fall:**	**September-October**

(1) <u>Pattern One - Lows moving from the northwest</u>. In this pattern, one might expect primarily Alberta Lows (Type A) and the more zonal Type B. On some occasions, a Type C cyclone moves out of Alberta into the Great Lakes. Fronts with this pattern are very common in the summer when the principle storm track is north of the Lakes into Quebec.

Percentage Frequency By Season

Winter (15) Spring (15) Summer (23) Fall (26)

(2) <u>Pattern Two - Lows moving from the southwest</u>. This includes Types D and E. Note the spring maximum which coincides with remarks made in Region 4.

Winter (15) Spring (22) Summer (14) Fall (15)

(3) <u>Pattern Three - Stagnating fronts</u>: This occurs in winter when a type C pattern is somewhat north of normal causing a stationary front over the southern Lakes. It also occurs when an occluded front becomes stationary across Michigan in a Type D pattern. With all types, an arctic front can get hung up in the Great Lakes. Note again the winter-spring maximum.

Winter (14) Spring (16) Summer (12) Fall (8)

(4) <u>Pattern Four</u>: Cyclonic flow occurs over the Lakes <u>any</u> time a developing low moves up the west side of the Appalachians (Type E), becomes stationary in the eastern Lakes (Type D) or results strictly from an upper air system as in Type E_s. The pattern though is significant when deep occluded systems move into or out of the Great Lakes to the east. Ridging on the surface lies north-south from Missouri through the Dakotas to Manitoba. Cyclonic flow between this ridging and downstream ridging over Labrador or eastern Quebec allows the Great Lakes to modify the general climate south and east by snow squalls in winter and cool temperatures in winter and summer both. Note winter maximum.

Winter (25) Spring (18) Summer (15) Fall (19)

(5) <u>Pattern Five - Stagnating Highs</u>: Type Y as described in the Introduction. Also may include Types B_3 and E in summer only.

Winter (7) Spring (7) Summer (12) Fall (11)

The influence of the Great Lakes is considerable, even though the individual lakes are narrow. Over-water trajectories are long only for specific areas and certain wind directions. The temperature of the Lakes are cool enough so that they are effective sources of moisture only under specialized circumstances and in local areas. In comparison to terrain effects, however, the influence of the water is much greater. The highest elevations in northern Michigan are barely 2,000 feet.

a. Winter: Limited areas receive substantial snowfall from the interaction of cold continental air with the relatively warm lakes. From December to April, lake temperatures range from 33°F where ice-bound (by convention) to 40°F. in southern Lake Michigan (Lakes Erie and Ontario not considered). On shores where flow trajectories are long, substantial snowfall occurs inland to about 40 miles. Topography is not nearly so important as wind direction and may be disregarded in general. The only exception is northwest Lower Michigan.

The ideal situation, assuming a proper trajectory, occurs with cyclonic flow (pattern 4). When air-lake temperature differentials are significant, and the synoptic pattern is stable, additional troughing will develop from instability caused by lake heating. Cyclonically-curved snow bands paralleling the flow may be seen on radar with usual dimensions of 25 to 100 miles long and 50 miles wide. Southwesterly flow may increase the amount of aerosols suitable for condensation nuclei and thereby increasing snowfall somewhat. Pollution centers range in a line from Chicago to Detroit.

b. Summer: Limited areas near the shoreline are susceptible to small precipitation irregularities and lake breezes. Lake temperatures are colder than land which tends to restrict air mass shower activity and clouds in general. Frontal weather is not affected to any important degree. Lake temperatures vary widely by locale and month. Open water may reach 50°F in Lake Superior during August and 65°F in Lakes Michigan and Huron. Shoreline temperature is warmer as is the southern part of Lake Michigan.

The lake breeze is a pure sea breeze circulation caused by unequal heating in the daytime. Rising air over warmer land lowers the surface pressure and encourages onshore flow.

REGION 6

The area covered lies between the Mississippi River and the Appalachians and from 200 miles north of the Gulf coast to the southern border of the Great Lakes. Winters tend to be cold with alternating intrusions of mT air followed by cP outbreaks. The cP air mass becomes increasingly modified as one moves southward through this region. The southern portion of the area is almost exclusively mT air during the summer.

The synoptic types that affect this area the most are Types D and E. Type B will also cause some weather depending upon the upper air configuration. Region 6 is on the eastern edge of tornado and hail maxima and in recent years, some dramatic severe outbreaks have occurred in this region.

Scott is almost in the Plains as far as synoptics are concerned. Weather changes are substantial during the year. Because of the shape of the Mississippi Valley, mT air is an infrequent visitor in winter but persists in a modified state through most of the summer.

Moving eastward, Grissom's climate is more typical of the Ohio Valley stations. There is a definite springtime precipitation maximum. This is in contrast to the stations in the Great Lakes where all months are equally moist. The prevailing flow at Grissom is a little too westerly for the Great Lakes to exert more than an occasional influence on the base. As at Scott, severe weather is quite common from March through July. At other Ohio Valley stations further east, the overall weather patterns are much the same.

REGION 7

A rather large collection of synoptic circumstances affect the Northeast which in this discussion includes only New York and New England. Unlike the West Coast, however, the division of synoptic types is much easier. A large number of hybrids exist for Types B and E and occur primarily when either a progression or retrogression of the major long waves is taking place. For discussion purposes, refer to the Synoptic Type Discussions in the Introduction for Types B, B_1, C, D, E, E_s and for summer B_3, E, and X.

REGION 8

This region covers the coastal area east of the Appalachians from New Jersey southward to Virginia. Although the distance spanned is short, the weather is completely different than New England with essentially the same synoptic types. Note especially Types B_2, B_3 and E.

REGION 9 SYNOPTIC DISCUSSION

The basic synoptic patterns of southern California are greatly simplified because of the pronounced tendency for ridging in the mean over the Far West throughout the year. General troughing off the West Coast is intermittent and generally weak south of 40°N. Even further west, strong subsidence supports the semi-permanent North Pacific High which is the major climatic influence on southern California. The Pacific High deflects surface lows and opposes frontal activity. In addition, subsiding air is dynamically warmed so that it forms a strong low level inversion that confines cool moist marine air to the lowest 2,000 feet of the atmosphere in most situations. Lastly, anticyclonic circulation establishes a northwesterly flow that prevails most of the year. All three effects are extremely important to forecasters at all coastal stations, especially at Vandenberg where forecast problems are especially severe.

In the high desert (VCV and EDW), the Great Basin High is as important in winter as the Pacific High. On occasion, cold air borne by strong northerly winds moves into the desert off the Basin High. When neither high dominates the pattern, strong fronts move through the area and account for most of the precipitation at these stations. In summer, the Pacific High and thermal low over the lower Mojave Desert account for strong southwesterly flow in the Los Angeles Basin and very high temperatures in the desert.

(1) <u>Type B, Winter</u>: "Zonal Flow": Combines Types A, B and E. Moderate to strong upper level ridging occurs over the Far West. Surface highs in the Pacific and Great Basin maintain fair and dry weather in southern California. Cold fronts may approach from the northwest but are dry due to frontolysis by the time they reach southern California. Offshore flow allows stagnation to occur (not severe) with warm hazy conditions inland and only small amounts of stratus or fog along the coast.

(2) <u>Type C, Winter</u>: "California Low": A deep upper low cell is centered over the California deserts with strong ridging through the Pacific Northwest. Northwesterly flow keeps the weather cold and dry along the coast with somewhat deteriorated conditions closer to the center of the low. A building Great Basin High encourages Santa Ana (Foehn) winds which are strong at times. In this situation, VBG receives less wind than other southern California stations.

(3) <u>Type D, Winter</u>: "Colorado Low": Pronounced troughing from the West Coast into the Rockies encourages more southerly storm tracks. Building high pressure behind surface lows

encourages Santa Ana winds with this synoptic type as well.

(4) Type E_s, Winter: "Gulf Low": Low pressure systems off the southern California coast both surface and aloft can induce heavy rains over southern California. Frontal activity is high in comparison with other synoptic types. Several days of occasional rain and intermittent ceilings are likely.

(5) Type B, Summer: The usual Summertime upper air pattern has a surface reflected high or ridge in Texas, another ridge north of Hawaii and a weak trough near the West Coast. The surface North Pacific High is west of California and semi-permanent, so that northwest flow prevails on the surface along the coast. Fog and stratus plagues low coastal stations and early in the season moves east out of the Los Angeles Basin. Typically, inland stations have a warmer drier climate than along the coast. Occasionally, southeast or south flow aloft brings in moist air from the tropics. Thunderstorm activity is common in the mountains. Watch out for development of a cut-off ridge in the Plains.

REGION 10

SYNOPTIC DISCUSSION

The basic synoptic patterns of southern California apply to the Desert Southwest as well. The North Pacific High deflects surface lows and opposes frontal passages. Subsiding air is dynamically warmed so that it forms a strong low level inversion that confines cool moist maritime air to the lowest 2,000 feet in most situations. Anticyclonic circulation establishes a northwesterly flow that prevails throughout most of the year. All of these effects are extremely important along the coast, less so over the Desert Southwest.

a. Type B, Winter: "Zonal Flow": Combines Types A, B and E. Moderate to strong upper level ridging over the Far West with surface highs off the California coast and in the Great Basin keep the Desert Southwest fair and dry. Cold fronts may approach the area from the northwest but are usually dry.

b. Type C, Winter: "California Low": A deep upper air low cell is centered over the California or Arizona deserts with strong ridging over the Pacific Northwest. If the low cell is right over Arizona, a moderately large amount of weather will occur. If just to the west, frontal activity can be expected in Arizona. If east of the area, northeasterly flow aloft keeps weather dry but cold.

c. Type D, Winter: "Colorado Low": Pronounced troughing from the West Coast into the Rockies encourages a more southerly storm track. A developing surface low in Nevada or Utah will cause a moderately active cold front to pass the Desert Southwest stations. Gusty surface winds develop behind the low as the Great Basin High builds.

d. Type E_s, Winter: Low pressure systems aloft off the California coast induce widespread precipitation and clouds in their southeast quadrant. The exact position of this low determines if frontal activity will affect the Desert Southwest.

e. Type B, Summer: "Low Amplitude Flow": High pressure cells or ridges exist in the Southeast, north of Hawaii with a weak trough off the West Coast. Inland stations are very dry and hot, since marine air does penetrate far inland. Occasionally, southeast flow draws in moist air from the tropics. The mountain areas have copious thunderstorm activity in the afternoon and evening. Whether or not individual bases have thunderstorms is directly related to terrain and upper flow direction and speed. An unusually strong ridge aloft through the Central and Northern Plains increases the moisture flow into the Desert Southwest.

A climatic overview of Nellis can only stress the severely dry climate plus its marked continentality. In winter, cold

fronts or upper air troughs cause some cloud and light precipitation. Winds are a serious forecast problem since very low visibility can result from dust raised at the surface. Summer is very hot with isolated air mass thunderstorms typically found in the mountains during the afternoon. Surges of moisture from the tropics enhance this activity.

The same ridging which protects much of southern California also shields Arizona. The Great Basin High builds in winter causing strong winds in the Phoenix area. In summer, most of the air mass thunderstorms occur in the mountains to the northeast. Subsequent movement is generally to the northwest avoiding the Phoenix area.

Further east, the dominant feature is the Great Basin High which tends to deflect frontal systems and surface lows away from New Mexico. Upper air troughs affect this area somewhat more than Arizona. The east side of the Rockies experience "backdoor" cP outbreaks and subsequent overrunning when warm moist air begins to move back from the south and southeast over the cold air. In summer, the Bermuda Ridge allows moist air to move in from the Gulf of Mexico.

REGION 11

The area described by south-central Kansas, west and central Oklahoma and the corresponding portion of Texas has a continental climate tempered by periodic Gulf air intrusions in winter with moister weather in summer (except for the far west portion) as southerly low level flow dominates. There is a north-south oriented boundary in Texas and Oklahoma that generally means the difference between a wet and dry year. Oklahoma City is just barely on the dry west side in the mean. The wettest period when surface lows originating in Texas and quasi-stationary cP fronts generate thunderstorms with severe weather in many cases. Late in the fall, a second precipitation maximum occurs as winter stroms begin. Winters overall are drier because much of the precipitation is light falling into continental air as it is overrun by moist tropical air. Stations in the western half of the area are drier than those in the east.

REGION 12

For a starting point, refer to the Region 11 discussion above. The eastern portions of Texas which comprise Region 12 are somewhat different climatically from west Texas and Oklahoma. The climate is more humid in the mean but not as moist as Louisiana and areas further east. Lows that develop in east Texas or in the Gulf produce heavy precipitation and low ceilings over a wide area. During winter, at least 2 inches of precipitation falls per month, but springtime fronts and squall-lines combine to produce the wettest time of the year. In the north portion, severe weather is more common than in the south half.

In the southwest portion of the area lies the central Rio Grande Valley which is drier than the rest of east Texas. Incursions of spring and summer stratus are relatively common, but winter precipitation is lighter.

The Houston area defines yet another significantly different area. Maritime and continental air masses regularly alternate in winter (as in north Texas), but maritime tropical air utterly dominates the summer half of the year. Ellington has a late summer precipitation maximum instead of one in winter. This is probably due to the higher incidence of coastal thunderstorms in late summer and less air mass activity inland. The lack of a winter maximum may be due in part from Gulf waves developing far enough north to keep EFD out of the precipitation shield.

REGION 13

The area of interest lies along the coast from east Texas to the Florida panhandle east of Appalachicola and extends about 300 miles inland (overlapping Region 6). Winters are mild with maritime tropical air alternating with greatly modified continental polar air. Precipitation is copious with at least three inches expected in all months. Snowfall is rare and freezing temperatures at worst occasional. The summer is warm and humid as maritime tropical air prevails almost exclusively. Air mass thunderstorms occur in large numbers and when combined with tropical disturbances produce monthly precipitation averages of five inches or more.

In winter and spring, Gulf waves develop in the western and central Gulf of Mexico when cold fronts stall and begin to turn warm. Development is almost assured when a migratory upper level low or sharp trough passes through El Paso on its way east.

The waves move from central Texas if the upper level low crosses ABQ and has some northerly component of motion forward. With weak or sluggish upper air support, Gulf waves remain quasi-stationary and affect the western Gulf area principally. The moving wave tracks in a direction somewhat more easterly than the upper level low and about as fast. Waves that have little amplitude remain offshore moving zonally until they reach Florida. Monitoring pressure tendencies will indirectly show movement since a weak north-south oriented trough on the surface often extends north from the wave crest.

Gulf waves generally contain classical warm front weather east and north of the wave center. The worst ceilings occur within six hours of warm front passage. Thunderstorms are also possible. Except for the stronger Gulf waves, warm sectors and cold fronts are not serious forecast problems. If the wave passes by just to the south of a station or if the wave should occlude upstream from a station, warm front weather will persist for 6 to 12 hours behind the low and about 3 hours after the occlusion passes. In both cases, severe weather is less likely than along an active warm front.

A distinction must be made between Texas or Gulf Lows and hybrids of Type B (Types B_1 and B_2) which really cause serious forecast problems in the eastern Gulf area and up the Atlantic coast <u>east</u> of the Appalachians only. A further discussion of these types can be found in the MXF and WRB Forecast Guides. In the western Gulf states, Types B_1 and B_2 behave like Types B, D and E.

<u>Winter polar outbreaks</u>: Slow moving cold fronts may spawn squall lines in the afternoon. Fast movers without much low level moisture contain middle cloud ceilings which persist a few hours after passage. Always watch out for wave

formation on a trailing cold front in the Gulf.

Winter fog and stratus occurs whenever quasi-stationary or warm fronts are south of a station and being overrun by moist southerly flow. Warm humid air is especially likely to cause morning fog over cold moist ground or bodies of water. It may be clear over the warm Gulf of Mexico, while stations located near positions of river discharge (colder water) may have fog. Any weak southerly breeze will tend to advect existing fog, whereas flow off the land will tend to dissipate the fog. Fog is not likely south of a front, unless the synoptic pattern is strictly diurnal.

Air Mass Thunderstorms: Gentle moist southerly flow in summer (strong subsidence absent) encourages air mass activity over the entire area, except along the coast where the activity behaves in a unique manner. Air Mass thunderstorms will develop in three ways depending on location:

(1) Over the Gulf, thunderstorms develop late at night and diminish after dawn. These storms are usually isolated, often drift along the coast in light easterly flow aloft and affect coastal stations at sunrise. Extensive thunderstorm activity over the Gulf at night is not an indication of incipient formation of thunderstorms inland during the day.

(2) Ten miles or more inland, air mass thunderstorms develop at noon and drift north or northwest and again diminish at sunset. Development is linked to the late morning sea breeze along the coast.

(3) Coastal stations are not routinely affected by air mass thunderstorms, but they may affect the local flying area. In deep southwesterly flow, however, general thunderstorm activity develops ahead of an approaching short wave trough aloft. (All areas may be equally affected). If a cold front approaches from the north or if the upper air flow is northwesterly, late afternoon thunderstorms will reach the coast and stall. These thunderstorms are continental in nature and may contain winds over 35 knots. Hail is extremely rare at coastal stations.

Offshore waterspouts may occur, even with cumulus congestus. Such activity is usually further out in the Gulf during summer. Tornadoes and hail are sporadic, preferring winter squall lines inland from the coast. Severe weather along the immediate Gulf coast is notably less frequent than inland.

Synoptic type information not in Introduction:

a. Type A, Winter: Trailing cold fronts may move into the Gulf but will completely wash out. Cooler air behind front is greatly modified and may be indistinguishable.

b. Type. B. Winter: Modified maritime polar air moves in from the west. Gulf waves ocassionally develop in the eastern Gulf and move up the East Coast (See Type B_1).

c. Type C. Winter: Persistent ridging keeps the Gulf coast unseasonable warm. Stagnating air reduces the visibility.

d. Type D. Winter: Cold fronts from the Colorado Low are pushed into the Gulf by a mild polar outbreak. Normally the cold front is so far away from the center of action that no wave will form on the trailing front unless it remains stationary in the Gulf for a prolonged period. Inflow ahead of the deep Colorado Low may cause stratocumulus ceilings along the moisture axis in the western Gulf states.

e. Type E. Winter: A major storm may move from the western Gulf towards the Appalachians. The polar outbreak will be moderately strong.

f. Type E_S. Winter: The major difference from other patterns is that flow aloft is especially conducive to wave formation. Fronts pass through southern California and are able to redevelop under the influence of migratory troughs aloft. Gulf waves of this type track on a more easterly course and normally do not recurve.

g. Type B. Summer: The Bermuda Ridge is in position and draws in moist maritime tropical air. See discussion on thunderstorms above.

h. Type E. Summer: Occasional fronts and weak polar outbreaks affect the northern portion of the area in mid to late summer. Thunderstorms are a problem with a continental air mass and may be severe.

Miscellaneous: At Little Rock, fronts moving in from the northwest are picking up moisture as they move, so precipitation at the base is almost as high as for stations further south. The mountains to the northwest slow fronts and create many secondary effects but do little to slow up outbreaks of continental air. Summer air mass thunderstorms are regular but of considerably less density than over the mountains. Thunderstorms that form over the mountains tend to drift away from the base in mean southerly flow. Little Rock and Blytheville both are north of the generalized track of Gulf waves and hence have somewhat higher winter precipitation than in summer. In other areas of region 13, terrain is not so much of a factor.

REGION 14

Region 14 extends from North Carolina to southern Florida. In the northern half of the area, the Bermuda Ridge dominates late spring and summer weather. Air Mass thunderstorms develop most frequently from June through August with twice as much precipitation as in other months. In winter, cP, mP and mT air masses alternate. Generally, mP air comes from the northeast, whereas cP comes from the west and northwest. In the southern half of the region, easterly flow around the Bermuda High prevails throughout much of the year. Winter forecast problems are largely confined to Gulf waves (Type E_s) and the southern edges of greatly modified continental polar outbreaks. In summer, the trade circulation overwhelms any other synoptic pattern. A precipitation maximum exists in central and southern Florida from May through October indicating the importance of thunderstorm and easterly wave activity.

a. Type B, Winter: Broad but shallow troughing over the eastern third of the United States allows cold fronts to trail into the Southeast. Two prominent sub-types are the Hatteras Lows and the Panhandle Lows (Type B_2) whose parent troughs originate further west.

b. Type B_1, Winter: This type differs from Type B stable Gulf waves or waves that develop in E patterns and go up the west side of the Appalachians. The associated surface wave is clearly unstable. It usually hangs up in the Macon, Georgia area and reforms near Hatteras. Expect increasing warm frontal overrunning with ceilings deteriorating rapidly. Precipitation begins to taper off once the redeveloped low reaches a point opposite the Virginia Capes, but clouds hang around until it is well up the East Coast or until east of 70°W.

c. Type B_2, Winter: The Panhandle Stable Wave occurs in a relatively slow zonal but definitely split flow (somewhat like E_s) as systems pass under a major ridge over the northern Mississippi Valley. This type is very common and although usually "stable" may redevelop over the Gulf Stream and recurve. The actual position of the center with respect to each station determines the weather.

d. Type C, Winter: Pronounced ridging over the Southeast allows a surface high to form northeast of the region out over the Atlantic. Stagnation and onshore flow are characteristic of this high, and some forecasting difficulty should be anticipated. Storm tracks are well to the north.

e. Type D, Winter: This region is so far away from the center of action, treat like Type C.

f. Type E, Winter: The warm front extending eastward from a Texas Low presents some special difficulties for stations east of the Appalachians. The movement northward of the warm front is apt to be discontinuous east of the mountains and retarded as much as 12 hours.

g. Type E_S, Winter: Treat like Type B. Waves tend to move into Florida and only marginally affect the northern half of Region 14.

h. Type B, Summer: The Bermuda Ridge extends westward across most of the Southeast. Most cold fronts will fail to reach the area. Air Mass thunderstorm activity is quite regular.

i. Type E_S, Summer: In this pattern, the Bermuda Ridge is displaced south or southeast, and fronts are more likely to pass through the area. The weather in general is noticably drier.

Note: Refer to the Patrick Forecast Guide for more information on how the major synoptic types affect the three central and southern Florida stations.

CHAPTER III

INDIVIDUAL REGION FORECAST GUIDES

REGION ONE

PACIFIC NORTHWEST FORECAST GUIDES

McCHORD AFB (TCM) FORECAST GUIDE

1. UNITS SUPPORTED: MAC Wing and ADC Fighter Group. McChord has only one active runway. A crosswind component of greater than 15 knots grounds the ADC alert force. A wind of greater than 25 knots accompanied by precipitation makes outside maintainence of C-141 impossible. Transition flying of these aircraft is also not allowed with a crosswind of 25 knots or greater, ADC uses 300 feet and/or 1 mile for training minimums. Snow or freezing rain in any amount is operationally significant as there is only limited means for removal.

2. PHYSICAL DESCRIPTION AND LOCATION: McChord Air Force Base is located one mile south of Tacoma, 25 miles south-southwest of Seattle and 80 miles east of the Pacific Ocean. It lies on a small plateau above and a short distance away from Puget Sound at an elevation of 322 feet. Tacoma proper lies right on Puget Sound and has heavy pollution sources right in line with runway 16. Numerous gullies connect the plateau with Tacoma itself which is at sea level. The area around McChord is mainly second growth douglas fir and brush in the east-south-west direction with urban development to the north. Pulp mills and an aluminum plant lie right on the water north-northeast of the base. The Cascade Mountain range averages 6,000 feet and begins to rise 25 miles to the east and southeast of the base. Mount Rainier, 14,410 feet, is 35 miles southeast. The Olympic Mountains, averaging 3,000 feet, rise to the northwest. Between the Olympics, Capital Peak (just west of Olympia - 2,658 feet) and the Willapa Hills southwest of TCM, there are open valleys exposing the McChord area to the Pacific through which moist cool air funnels. To the east and southeast, there is gently rolling terrain broken only by two small river valleys until the Cascade foothills are reached. Moisture is also funneled through Georgia Straits (between Vancouver Island and mainland British Columbia) and through Puget Sound itself.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: In forecasting for TCM and GRF (Gray AAF). knowledge of terrain is the single most important aspect. Easterly components and northerly components of wind (late spring through early fall) in the low levels will dissipate cloudiness. Forced by the terrain, the wind generally blows from the south-southeast or the west-southwest. Winds from the north are generally light. There is always

BRITISH COLUMBIA
CANADA
UNITED STATES
CGAS PORT ANGELES
NAS SEATTLE
TACOMA
SANDERSON FIELD
CENTRALIA

potential for fog and stratus, and forecast wind direction is of paramount importance. Northwest through northeast flow comes right off the water and runs upslope to the station. Northeast through south winds are in a neutral or downslope configuration depending on speed. Southwesterly winds are always moist but are neutral with respect to terrain.

b. Transient Controls: Large high pressure cells which can build up in the interior of British Columbia from late fall through spring will occasionally cause very cold air to spill down the Fraser River Valley into Puget Sound. These occurrences are rare but bring unseasonably cold weather to the Sound area and provide the possibility of snow, freezing rain, etc. (See Section 5 also). During the summer months, the thermal low in the southwestern states often extends northward into the Columbia Basin. When the trough is strong, onshore flow will generally take place into the McChord area. Advection of the moist maritime air makes morning stratus a common occurrence.

4. SYNOPTIC TYPES AND FORECAST RULES: See also Synoptic Type Discussion in Chapter 1.

a. Type A: This synoptic type is associated with a well developed Aleutian Low aloft near 165°W with deep southwesterly flow from 30°N 150°W across Washington. Storm systems originate northwest of Hawaii and move northeast toward Vancouver Island. The associated frontal waves which form along the mP boundary normally develop as warm-type occlusions or occlude once over the colder land mass. Sometimes they are in the decaying stage by the time they reach the Cascades. This occurs because of mean divergence aloft in the upper pattern. The strength of the system is directly related to the strength and direction of the flow aloft and curvature of the upper air trough supporting the surface system.

(1) Clouds: Category B 4-6 hours of the front and 2-3 hours after will raise to C category as the air mass becomes more unstable. Moderate to heavy rime icing and cloud tops solid to 35,000 in vicinity of TROWAL (trough of warm air aloft). Waves come in a series - usually 5-7 in a 12-14 day period. Passages are usually 24-36 hours apart but can be as little as 12-18 hours if the waves are more poorly developed. Forecast middle clouds between waves. Do not clear them out until there is sufficient evidence that the wave series has ended and high pressure has built in along the coast.

(2) Visibility: Category B or C depending upon the intensity of precipitation and temperature of the air ahead of the front (colder - more fog). Rapid improvement will occur behind the front until arrival of next wave.

(3) Precipitation: Steady moderate precipitation in the vicinity of the front; intensity related to strength and upper air support of frontal wave. Some showers will linger between waves as long as middle clouds exist.

(4) Winds: 15-25 from the southeast before front except 35-45 with intense systems. If a rapid pressure rise is expected behind the front, stronger winds will occur. Otherwise they will fall off (from the SSW) after the front passes. Keep in mind that west-east oriented isobars produce stronger winds at TCM than north-south.

b. Type B: Aleutian Low is less active and further north. Flow aloft is nearly zonal over Washington, although embedded minor troughs may have large amplitude. A surface low is active in the Gulf of Alaska. Storm track is eastward into British Columbia. Trajectory of fronts is east and southeast through Washington. The air mass is more unstable in the mean, and occlusions are predominantly of the cold-type.

(1) Clouds: Layered high and middle clouds over stratocumulus in advance of the front deteriorating to C category at time of passage. Intermittent B conditions in following showers are possible. Cloud tops average near 30,000 feet at TROWAL with moderate mixed icing. Improvement in 3-5 hours is often rapid to low D category especially if the winds are strong.

(2) Visibility: No restriction until precipitation starts, then D category with the front and intermittent C in showers.

(3) Precipitation: Unsteady light precipitation in advance of the front with moderate rain and showers as the TROWAL passes. Embedded cumulonimbus is common.

(4) Winds: Winds are generally south 10-20 before passage and may be considerably stronger behind the front due to isobar orientation (35-45 knots with the stronger systems). Look for rapid ridging behind the front as winds shift to the southwest through west.

c. Type C: The Aleutian Low is forced to the dateline so flow turns to the northwest through northeast. Blocking ridge over the Gulf of Alaska, Alaska and western Canada. This type comes in varying forms, but the classical arctic outbreak down the Fraser River and through the Cascades occurs when a cold high builds up in central British Columbia to the Yukon of 1054 mb with an elongated trough from the Washington-British Columbia border into the Gulf of Alaska. An easterly component to the upper wind must exist (010-040 degrees) over British Columbia.

As an upper impulse moves southward around the ridge aloft, a frontal wave forms in the southern Gulf of Alaska and tracks across Washington. This wave is a mild cold-type occlusion, but the circulation around it is sufficient to pull the arctic air into Puget Sound. The classical type is rare, but variations on it are common and can under abnormal conditions occur in the summer. Consider also the following:

(1) After the cold air is settled in Puget Sound, immediately start watching for moist overrunning of the cold air. Waves moving from Vancouver Island down the coast of Washington cause as much as 10 inches of snow at McChord. A small system sneaking across the base of a surface ridge and approaching McChord can do the same thing.

(2) If the cold air is not sufficiently deep to reach TCM, forecast the weather as in (3) through (6) below, but WATCH OUT for the effects of cold air drainage or modification of established cold air. For instance, a surface low may form off the coast and stay there for a few days. This dries out the Puget Sound area. Another example is a surface low moving through north Puget Sound which produces onshore flow.

(3) Clouds: If the arctic front can be picked up and is expected to pass TCM, forecast B category ceilings with INTER A in snow; cloud tops around 14000 feet. Two to four inches of snow are possible. Improvement to clear may be forecast in six hours if the cold air is deep. Light rime icing is common with this type of system, both with the occlusion and the arctic front. With the occlusion which passes through the area before the arctic front, expect low C or high B category clouds with tops around 20,000 feet. No clearing is likely between passage of the two fronts. If there is no arctic front, clear to scattered conditions are likely in six hours.

(4) Visibility: C category visibility in precipitation and light fog will deteriorate to B intermittent A with arctic front. Expect rapid improvement as soon as the precipitation stops.

(5) Precipitation: Light rain and steady drizzle ahead of the occlusion changing over to snow with the arctic front. Precipitation ends as long as there is no mechanism for continued overrunning.

(6) Winds: Winds are generally less than 20 knots with both fronts and may be L/V at times. Ignore the 35-55 knots winds at BLI as this is just an indication of cold air drainage from the Fraser River.

5. **SEASONAL FORECAST RULES:**

WINTER: (clouds)

a. All synoptic types occur in winter including some of the hybrids discussed in the Introduction (Types A_1, B_2, C_1 etc.). One peculiarity to watch for is a cold/cool mass of air under an inversion over land. This may be indicated by a general lack of wind ahead of a moderate frontal system. Rain into this cold air will produce category B ceilings well ahead of frontal passage, a situation which will not occur when strong outflow winds occur.

b. Short periods of advected stratus or rising ground fog may occur with a northerly drift. Because of the sandy soil around TCM, do not expect this routinely after a hard rain.

c. Fog which is expected to form due to winter radiation may "frost" out but again cause a problem after sunrise as the temperature rises above freezing.

WINTER: (winds)

a. Strong winds only occur when isobars are oriented in Puget Sound from southwest-northeast or west-east. The most common orientation is north-south.

b. Winds greater than 35 knots are not observed blowing from the northwest-north-east.

c. BLI and HQM can not be used as wind indicators for TCM and GRF.

d. Forecast the maximum gust speed with winds from south through west by multiplying the PDX-SEA pressure gradient by five.

e. Wind speeds rarely exceed 25 knots except in advance of B type and behind strong A type fronts.

WINTER: (precipitation)

a. When ACSL clouds are <u>first</u> reported over Mt. Rainier (a remark often carried), precipitation will begin at TCM and GRF within 24 hours.

b. Using the UIL raob (797), forecast the beginning of precipitation when the cloud base is expected to reach the freezing level.

c. Snow can be expected with any system with a trajectory from Vancouver Island to Portland, Ore. or from off the Columbia River mouth and thence eastward. If a low develops into a large system and stays in western Washington, the snow will usually change to rain.

d. Snowshowers can be expected if a low remains stationary off the coast sufficiently long to allow cold air to drain into Puget Sound.

e. A freezing level above 1800 feet MSL usually means rain.

<u>SPRING</u>:

a. Sometime in March or early April, a two-week period of absolutely clear weather occurs at TCM and GRF. (Watch for strong upper air ridge building right over the West Coast).

b. Precipitation is more convective in nature owing to the cold unstable air masses moving from the Gulf of Alaska and warmer surface temperatures over land. With onshore flow, start off with a C category stratocumulus deck in the morning and break to D category cumulus or scattered cumulus in the afternoon with some category E altocumulus above. Clearing is expected by 1700L, and the cycle repeats itself after midnight. This is <u>not</u> the same pattern as the diurnal stratocumulus regimes discussed below.

c. Strong winds, extensive B category ceilings and fog are the exception in spring due to the instability of the air mass in the mean.

<u>SPRING-SUMMER</u>:

a. Diurnal pattern with no upper troughs within 300 miles. Stratocumulus will go broken in D category in late afternoon for approximately 4-6 hours between 22Z and 04Z then clear up until 08Z. Between 08Z and 10Z, TCM and GRF will go broken again this time in high C category or very low D. (Generally TCM is a bit lower in this case). This condition is usually accompanied by light southeasterly or downslope winds. The first indication that the lower ceilings will form is the appearance of altocumulus 4-5 hours prior to formation of the lower clouds.

b. With a flat gradient and an afternoon sea breeze off the sound, stratocumulus will form at a height of 3,000 to 5,000 feet and get packed up against Mt. Rainier to

the southeast. As the sea breeze dissipates, so do the clouds. The land breeze occurs again in the early morning with stratocumulus again forming as in rule a. above. Late in the morning the clouds clear up before forming over again in the sea breeze.

SUMMER: (clouds and thunderstorms)

a. Southwest stratus: This is a classical forecasting problem at TCM and GRF, most common in the summer but possible anytime from May to October. Watch for increasing pressure gradients OTH-SEA, PDX-SEA, decreasing $T-T_d$, building thermal trough over the Columbia Basin and passage of a weak trough aloft from the southwest to northeast. (Consult also satellite pictures for stratus distribution off the coast). Stratus will normally come in at C category if no synoptic system is in the area to mess things up. Breakup is normally about 12L unless the maritime layer is thick or becoming thicker (check 72797 raob). If stratus is still present at 18L, it normally will continue through the next morning unless a cold front passes from the northwest. These are a couple of items to consider when making the stratus forecast. At 0000Z, the following should be satisfied:

(1) AST-SEA pressure gradient should exceed 2.0 mb.

(2) Stratus should already be in at AST and in fact may not have broken at all during the day.

(3) TCM must have a southerly wind.

b. Northwest stratus is rare and extremely difficult to forecast 18-24 hours away. It comes down the Straits of Juan de Fuca through Puget Sound to TCM and to GRF about 30 minutes later. Continuity is the only way to forecast this phenomenon. If CKZT pressure is rising through 1021 mb, forget about it. Northwest stratus is normally a condition of 500 feet and two miles with breakup by 1200L. (SEA-OLM pressure gradient must be positive). It normally does not occur two days in a row.

c. Thunderstorm activity is maximum in summer. They normally occur when a northwest-southeast oriented trough aloft (usually a closed low) lies off the northern California coast for a few days and then moves northeastward. (TCM and GRF have high daytime temperatures). High level thunderstorms will begin to break out in the late afternoon or evening preceded by ACC clouds. If a maritime push occurs behind the trough passage, severe thunderstorms

can result, although the maitime air quickly stabilizes the lower layers.

FALL: (August through October)

a. Fog can occur in the winter with precipitation and in the summer with stratus, but classical radiation fog is most common in the fall with strong subsidence in the mean on a synoptic scale combined with greater nighttime radiation. October is the maximum month for A category conditions.

b. Fog will occur under the following conditions; A stagnant high pressure system over Washington and British Columbia producing a light northerly pressure gradient; a strong subsidence inversion (check 72797 raob), and active pollution sources in Tacoma . (which are not active on weekends). The smoke will thicken after sunset providing condensation nuclei. Unless a frontal system is approaching, breakup time is normally late morning.

c. If a front is approaching, expect the inversion to lift. This will often prevent the fog from breaking but will rise instead into a stratus deck as heights fall aloft. If a drying southeast wind is expected on the surface, the fog will dissipate.

FORT LEWIS - GRAY AAF (GRF) FORECAST GUIDE

1. UNITS SUPPORTED: Training 9th Infantry Division (Training) and non-divisional units including helicopters. Their training minimums are 1,000 feet and/or three miles. Snow or freezing rain in any amount are important as there is only limited means for removal. Advance warning is necessary for high winds so that helicopters and basic trainees can be protected.

2. PHYSICAL DESCRIPTION AND LOCATION: Gray Army Air Field (Ft. Lewis), Washington is located four miles southwest of McChord's runway and is basically on the same plateau as TCM at an elevation of 301 feet MSL. It experiences similar weather problems as TCM with pollution affecting this station in exactly the same way. The observing at GRF is even more severely hampered than at McChord. The base weather station observer does not have a clear view of the sky due to a hill in the southwest quadrant and must depend on the tower personnel to give visibility greater than two miles. Runway 15 has the only approach control.

3., 4. and 5. See McChord Forecast Guide.

BRITISH COLUMBIA
CANADA
UNITED STATES
CGAS PORT ANGELES
VOR
124°
123°
Forks
Clearwater
SANDERSON FIELD
Matlock
CENTRALIA
CHEHALIS CENTRALIA
CHEHALIS
South Bend
TOLEDO-WINLOCK
Toledo
NAS SEATTLE

FAIRCHILD AFB (SKA) FORECAST GUIDE

1. UNITS SUPPORTED: 92nd Bomb Wg (B-52, KC-135), 48th ARRS (helicopters), 3612th CCTS (Survival School). Special amendment criteria are 400 feet and/or 1 mile (ARRS minimums).

2. PHYSICAL DESCRIPTION AND LOCATION: Fairchild Air Force Base (2462 feet MSL) lies 12 miles to the west-southwest of the center of Spokane, Washington in a shallow southwest-northeast valley at the northeastern rim of the Columbia Basin. The Columbia Basin is defined by the Cascades 80 miles to the west, the Okanagan area to the north between the Cascades and the Rockies, the Rockies to the east and the Blue Mountains 100 miles to the south. To the south of Spokane, the Palouse Hills extend southward to the Snake River. The terrain is fertile and averages 3,000 feet , rolling and closely spaced. The Selkirk and Kettle River ranges lie to the east and contain several peaks in the 5,000 to 6,000 foot elevation range. To the north and west of the base is mostly barren until one reaches the foothills of the Okanagan. There are many small lakes and rivers in eastern Washington which have little influence on the local weather. However, increasing vegetation and irrigation will increase mean low-level moisture with time (see section 3). Under stable conditions in the winter, the wind direction is often light from the northeast or east-northeast. This can make the pollution-producing Spokane industrial complex to the east a major factor in the local weather. When conditions are ripe for fog, additional condensation nuclei from pollution increase the intensity and duration of the fog. During the summer, winds do not generally blow from this direction, and pollution is therefore not much of a problem.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Looking at the Columbia Basin on a raised relief map gives one the impression that it is totally surrounded by mountains averaging 5,000 to 8,000 feet. Physically this is true, but meteorologically there are two important breaks in this mountain barrier; the lower central Oregon ridges which allow modified continental tropical air associated with the summer thermal low to flow into the Basin, and the Columbia Gorge which allows advection of moist Pacific air into the Basin. It is true that the Rockies act as an air mass separater preventing continental air from reaching the Basin except on rare occasions. Within 50 miles of the base, there is a strong

upslope gradient from the southwest and northeast. Upslope from the southwest extends more than 50 miles out; however, upslope from the northeast is limited to 10 miles along a broad valley which runs into the city of Spokane at an elevation of 1935 feet. Windflow from the quadrant north through east is otherwise downslope. Beyond 50 miles to the southwest, the upslope is strong nearly 2,000 feet in 100 miles sloping down toward the Snake River to the south and Columbia River to the west. There is sufficient orographic influence to make modifications to the air mass both synoptically and locally. There is also some upslope tendency with southeast gradient winds past 50 miles from the station, but downslope is evident in this direction within 40 miles over rolling terrain.

b. Transient Controls: The effects on the weather induced by the major synoptic features are different than out on the Washington coast. Summer is characterized by very little frontal weather with a strong Pacific Ridge off-shore and some sort of thermal trough in the Basin. Frontal passages are weak although gusty winds and thunderstorms pose short-range local forecasting problems. During fall, there is transition to more frequent frontal passages in the mean with decreasing thunderstorm activity as the return of the polar jet and retreat of the thermal trough happen simultaneously.

There are two winter seasons at Fairchild which are peculiar with respect to the base's location versus the mean position of the upper ridge. Apparently, in the "early" winter (mid-November to mid-January), the climatologically normal warm ridgeline aloft is to the east of the station with a southwest jet in the mean over or just north of the station (Type A). In "late" winter, this ridge meanders westward and loses amplitude so that the jet has a more zonal character and comes from the north-west more in the mean. Early winter generally has more fog, stratus, freezing precipitation and frontal passages. Late winter generally shows a colder dryer sounding which is much less conducive to fog and stratus.

c. Air Masses: As at Mountain Home, there are basically four air masses that dominate the SKA area; Maritime Polar (mP) which stagnates or modifies to PB (Polar Basin) in the winter and to cT (Continental tropical) in the summer. cP or cA (continental air masses) occur more often at SKA than at MUO and arrive from the north through east. In the mean, however, these outbreaks are quite rare. When cP or PB air dominates the SKA area, it is quite possible for mP fronts to pass aloft over the colder lower level air. This can happen in any part of

118°
117°
48°
47°
CD
CC
Deer Park
FAIRCHILD
Creston
Davenport
Harrington
SPOKANE
Ritzville
Endicott
Winona
Colfax
Palouse
Thornton
Troy
Kendrick
LEWISTON
Nez Perce
WALLA WALLA
2425
2320
2200
3051
1796
2160
2056
1812
1974
2032
2373
(210)

winter. In summer, an mP front reaching the Cascades (assuming the marine layer exists in depth) will spill over the range and mix to the surface displacing the cT air in the Columbia Basin. Such fronts can produce actual squall-line activity.

d. Cold Fog Dissipation System: Fairchild has a cold fog dissipation system. Appropriate DENEB remarks are required by AWSM 105-24. Watch out for this and take into consideration when making a forecast for A category visibility.

4. SYNOPTIC TYPES AND FORECAST RULES: See also the Synoptic Type Discussion in the Introduction.

a. Type A: Southwesterly flow aloft parallel to initial occluded frontal passage. Waves follow in a series. Ridge over northern Rockies with sharp trough off West Coast. Surface waves form at triple points of occlusions reaching the Cascades. Surface lows may pass south of SKA. Jet initially over the Cascades moves eastward and to some extent southward with each successive wave (causes progression of upper trough).

(1) Clouds: Multi-layered stratiform, tops 300 to 350. C category ceiling if wave is north of station, D category if easterly drainage out of mountains prior to frontal passage, B category in snow and B category in vicinity of front. Slow clearing behind front until approach of next wave in series.

(2) Visibility: B category for snow, D or E category for rain. Expect B or possibly A visibility if moist light surface winds from the southwest are expected after the front.

(3) Precipitation: Occasionally moderate; lighter if surface low is north of station. Frozen or unfrozen based on surface temperature forecast. Snow is not likely unless easterly drainage is evident out of mountains before trough passage or with low passing to the south.

(4) Winds: Proportional to expected pressure gradient. Terrain does not force or change observed direction in general. Expect southeast winds prior to passage; southwest to west and likely gusting after passage for a few hours.

b. Type B: Zonal configuration; moderate jet across Washington. Trough flat in Gulf of Alaska; troughs, ridges migratory. Storm centers cross southern Canada and occur in a series.

(1) Clouds: Multi-layered stratiform with tops 250-300. Ceiling C category, D category if easterly drainage out of mountains prior to frontal passage and B category in snow. Short period of B likely with passage.

(2) Visibility: High D or E category visibility in rain slightly lower (not likely C) in light snow. Again, frontal fog A or B category likely if light moist south through west winds expected.

(3) Precipitation: Light to moderate frozen or unfrozen; snow not likely.

(4) Winds: South ahead of front, occasionally east, shifting to west-southwest behind front. Speed proportional to gradient.

(5) Icing: Light rime - moderate in vicinity of front.

SUMMER TYPE B:

(1) Clouds: Broken to overcast cumuliform, category C or low D (the latter is better to forecast in advance). Thunderstorms usually are disorganized, but a squall-line can form if the front is very strong and cT air is well established in the Basin.

(2) Visibility: D category in showers. Blowing dust may be a problem in the vicinity of thunderstorms.

(3) Precipitation: Showers.

(4) Winds: South ahead, southwest behind. Gusts possible with thunderstorms, 30-40 knots maximum.

(5) Turbulence: Light to moderate mechanical to 10,000 feet, especially if gusty winds are forecast.

c. Type C: This regime is similar to the Type C discussed for TCM and GRF. The classical Type C will produce a strong arctic outbreak into the Columbia Basin, but these are very rare. The more common occurrence shows the strong ridgeline at 130°W with northerly or northeasterly flow over eastern Washington. Waves moving along the quasi-stationary front separating mP from cP may produce outbreaks into the Columbia Basin. No Great Basin High exists. (See also MUO - Type B). Central pressure of high cells in British Columbia must be 1030 mbs. Forecast no weather at all except broken cirrus if the jet stream is east of the station.

d. Type D: Digging trough across northwest Oregon tracking across northern Utah. There is no Great Basin High cell. Affects SKA very slightly with scattered to broken ceilings above 10,000 feet and occasional snow showers, unrestricted visibility and no hazards.

e. Type E: Light northwesterly or westerly flow. Warm ridge over Northwest and British Columbia dominates deflecting storm track into Yukon. Strong surface inversion caused by radiation. Northerly jet over Rockies.

(1) Clouds: Over cast stratus (easterly or northeasterly wind) A or B category.

(2) Visibility: A or low B category late night and early morning. Becomes unrestricted by late morning or early afternoon. Remember about the cold fog dissipation system.

(3) Precipitation: None, but L-- or ZL-- possible.

(4) Winds: 3-5 knots.

(5) Icing: Surface rime common.

SUMMER TYPE E:

(1) Clouds: None.

(2) Visibility: Unrestricted.

(3) Precipitation: None.

(4) Winds: SSE 10-15 kts, E at 5 after midnight.

(5) Turbulence: Light to moderate mechanical surface to 10,000 feet. Temperatures are much above normal as thermal trough dominates.

f. Type E_1: If the high pressure cell is centered southeast of SKA, then a moist south-southwesterly flow will exist on the surface. If a strong nocturnal inversion forms, then a very extensive period of stratus/fog may occur. (See Winter Forecast Rules next section).

5. SEASONAL FORECAST RULES:

a. Most occlusions that pass through the SKA area are warm-front type occlusions. (See figure 1). Forecast accordingly. Remember the PB air mass is colder than MP.

b. Fog and stratus will occur when a moist southwesterly flow exists under a strong nocturnal inversion. If the regime begins as fog, it will likely break the first two days, but not the third. Regíme lasts until a frontal passage breaks the inversion and advects a drier air mass into the area.

c. cP·cA high cells must be 1045 mb or more before they will extend west of the Rockies into the Columbia Basin. Maximum wind flow should be north-northeast from northern Canada into northern California.

d. Persistent fog/stratus with strong inversion from subsidence normally breaks with strong pressure falls moving into the Pacific Northwest. If conditions are ripe for fog, but the pressure is falling or expected to fall, forecast no fog. If the fog has formed, lift it to stratus before breaking.

e. Negative vorticity advection or rising pressure at the surface enhance the formation of fog. Positive vorticity advection, minor troughs aloft or falling pressures decrease the possibility.

f. Forecast winds 12-18 hours in advance by considering pressure differentials for MRR, UIL, ALW and EPH.

SUMMER

a. Squall-lines are possible in the Columbia Basin when the afternoon forecast pressure is less than 1010 mb. The lower the pressure, the greater the likelihood of formation. Strong westerly or southwesterly flow must be present. A strong mP system further enhances the possibility.

b. Summer minimum temperature: $T_{min} = \frac{T\ max + T_d\ max - 12}{2}$

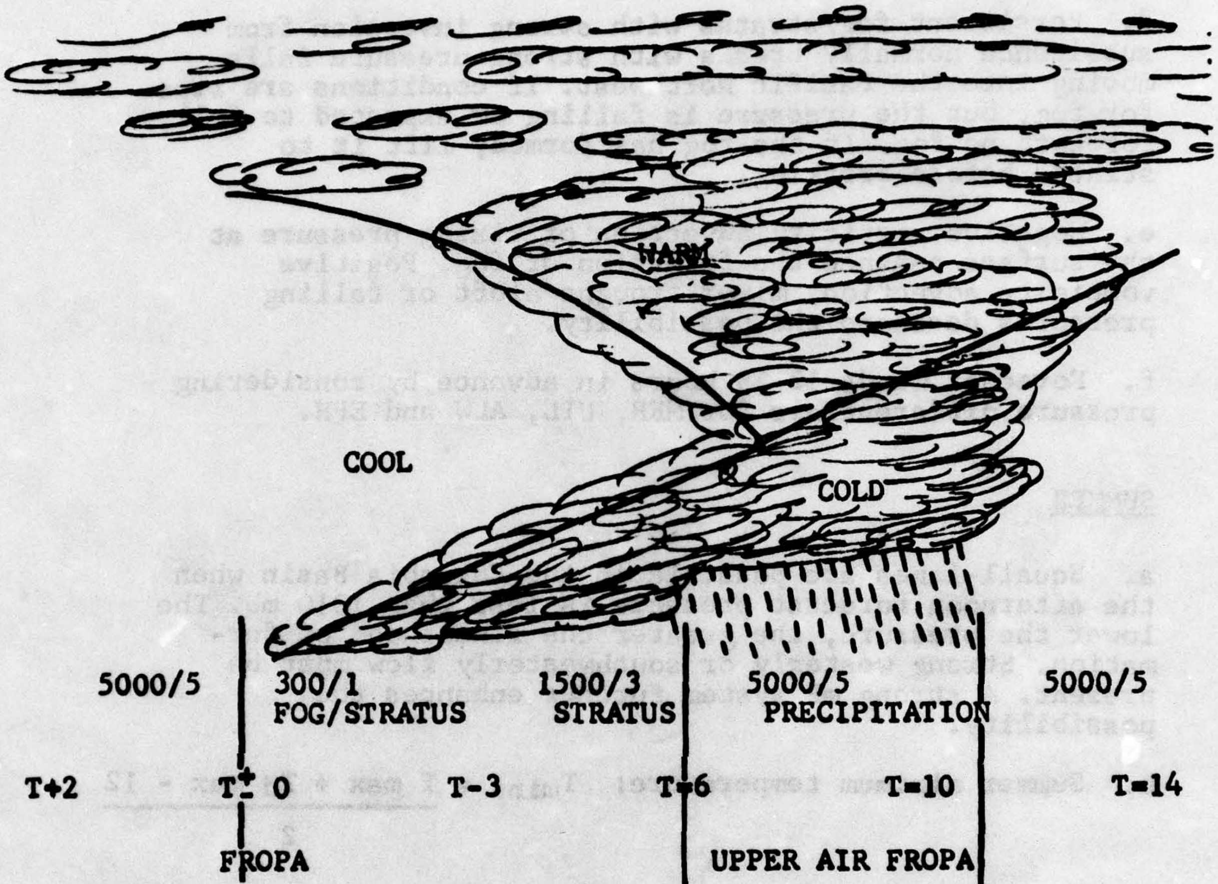


Figure 1 (SKA Forecast Guide) The figure shows an <u>idealized</u> weather time cross-section of a warm-front type occlusion passage at Fairchild.

<u>Comments</u>: Ceiling and visibility from T-3 to FROPA is not always less than 300 feet and/or 1 mile. Conditions depend upon the amount of precipitation with the upper air FROPA, wind direction and speed, and snow cover.

After T+2, weather may deteriorate in fog and stratus caused by radiational cooling.

Following passage of an intense upper-air cold front, weather conditions frequently improve to above 5000/5.

FROPA through T+2 weather may deteriorate in fog and stratus from moist upslope advection. After T+2, the weather may deteriorate from radiational cooling.

Essentially, the oncoming Pacific cool air pushes the warm air from the surface aloft west of the Cascades. In turn, the cool air is carried aloft over the colder PB air in the Basin.

MOUNTAIN HOME AFB (MUO) FORECAST GUIDE

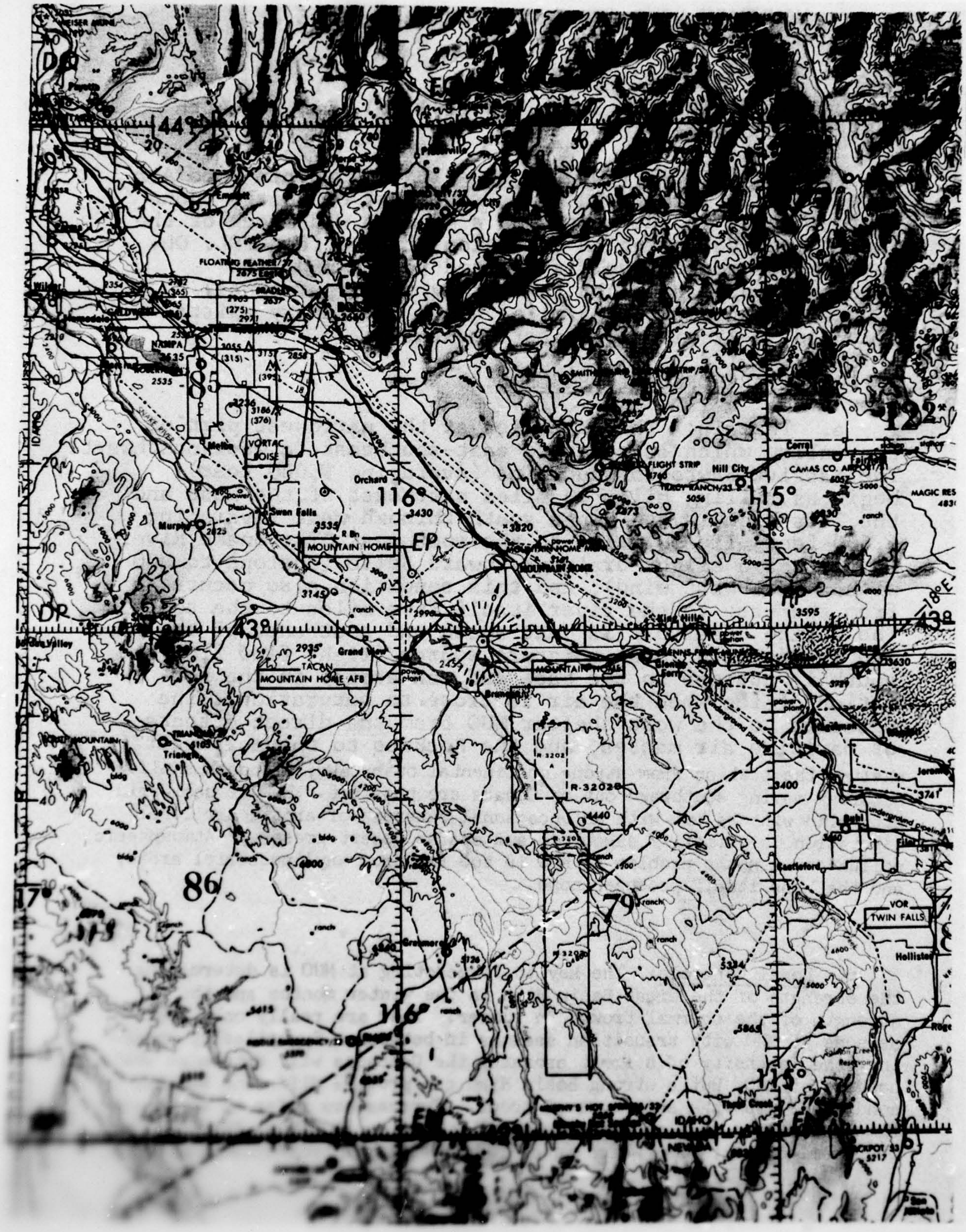
1. UNITS SUPPORTED: 366th TFW (F-111F), Det 22, 48th ARRS (helicopters).

2. PHYSICAL DESCRIPTION AND LOCATION: Mountain Home Air Force Base is located 40 miles southeast of Boise, Idaho approximately in the center of a 45 mile wide neck of the Snake River Valley at an elevation of 3004 feet MSL. Observing at ground level is limited to one and 7/8 miles both day and night (except by tower personnel). Mountains are visible 25 miles away. One runway exists oriented 30-12 with dual instrumentation.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The base lies at the narrowest part of the valley which is oriented east-southeast to west-northwest. The massive Sawtooth mountains (averaging 9,000 feet) begin as rolling hills 20 miles northeast of the base and the less high Owyhee Range south through west (averaging 6,500 feet) lie 30 miles to the southwest. The Snake River Valley has a slight drainage toward Boise (upslope to MUO with a northwest wind), and this condition also occurs from the base to the river itself five miles to the south. The Strike Reservoir is just south and southeast of the base and is the only local moisture source (light flow from the south is upslope to the base and can assist in the formation of fog when the air is close to saturation). The Cascades to the west shelter MUO from the direct effects of maritime air masses, and the Rockies to the northwest shelter the station from strong continental outbreaks, although shallow outbreak moving southward out of Canada are possible. MUO is semi-arid with mild winters but with an occasional outbreak of arctic air local vegetation is primarily sagebrush and sparse desert grasses. Atmospheric pollution is not a problem as MUO is too far from any industrial areas, and the base itself produces none.

b. Local Controls: The key to forecasting at MUO is determining the strength of the Great Basin High in the winter months and the strength of the thermal trough in summer. Ther are really only two seasons at MUO with transition seasons in between. Synoptically speaking, the intensity of a front crossing the Cascades will determine what happens at MUO, but a strong Basin High can provide differing weather conditions with the same type of front. Forecasters refer to mP (Maritime polar air) that modifies in the MUO area as PB (Polar Basin). This is a semi-dry air mass which is cooled primarily by nighttime radiation



44°
FLOATING FEATHER
NAMPA
Melba
VORTAC
BOISE
Orchard
116°
Murphy
Swan Falls
MOUNTAIN HOME
EP
Corral
FLIGHT STRIP
Hill City
CAMAS CO. AIRPORT
15°
MAGIC RES
43°
Grand View
TACAN
MOUNTAIN HOME AFB
MOUNTAIN HOME
R-3202
86
79
Grasmere
116°
Castleford
Buhl
VOR
TWIN FALLS
Hollister
IDAHO
NEVADA

as it stagnates. Stagnation of the mP air mass in the summer inevitably results in the cT hot and dry situation. Fresh outbreaks of cP air across the Continental Divide only occur once a year on the average. Frontal discontinuities and troughs are much more intense in winter than in summer. Mean storm tracks pass close to MUO in the winter as waves form on triple points of old occlusions passing the Cascades aloft and reforming over the Columbia Basin in divergent flow aloft. Strong winds, rapid shifting and abrupt weather changes characterize MUO frontal weather. In March through May and September through November, these fronts are generally seen to pass on the surface. In winter, however, the mP air mass has a tendency to ride up over the PB.

c. __Specific Forecast Problems:__

One of the most difficult forecasting problems at MUO is radiation-advection type cold fog which forms in dense banks and with little advance warning. MUO has done a lot of work on this problem, but no specific forecast parameters have been worked out partly due to the small number of cases. Presented here are some facts that bear on the problem.

The reason for the unusual fog density is because of the partial advection nature of the fog; namely, the fog is formed over the Snake River, and radiation creates conditions so favorable for fog that the original fog bank over the river maintains itself while moving across the short distance to the base. On occasions, this fog will blanket the runway but will leave the north half of the base in the clear. There is little warning because of the lack of visibility checkpoints. The following is taken from a paper by William C. Woodworth of Boise, Idaho regarding Snake River stratus and fog:

"Any forecaster in the mountain region must first be familiar with the terrain around his station. In the forecasting of fog in the Snake River Valley, this feature is most important. First it must be known that downslope conditions occur mainly from the south or southeast; upslope conditions occur from the north or west, since the Snake River meanders northward through central and western Idaho into a narrow and long gorge just north of Weiser, Idaho. A definite basin is thus formed that often traps moist maritime air into stagnation. The forecaster must also be aware in the winter of southwest circulation aloft which has persisted for two or three days and has caused above average precipitation in the valley. Subsequently, if a large high builds up over the Great Basin

following the storm that caused the precipitation, this high will trap unusually moist air near the lower 1,000 to 2,000 feet above the surface. This inversion forms often at 5,000 feet MSL, but it seems to fluctuate both diurnally and daily. If skies are only partly cloudy the first night, ground fog will form throughout the valley, usually beginning at Ontario (Oregon) and creeping southward occasionally bypassing the higher terrain near Boise and Mountain Home. After forming as ground fog the first night, the layer will thicken continually through the day to near 1,500 feet with lifting of the ceiling to the 4,000-5,000 foot range in the afternoon. As high pressure builds (1045 mb is not uncommon and may persist for 10-12 days), the inversion strengthens, and the fog continues. The deck will develop to 2,500 to 3,000 feet in thickness and often intermittent drizzle or light snow falls as the clouds are forced against the sides of the mountains rimming the valleys. The dissipation of the stratus thus formed is entirely dependent upon the breakdown of the high pressure system dominating the valley. Only a strong trough with active southwest winds aloft seem to be able to break the inversion sufficiently to ease the situation.

Another situation may occur when only part of the valley is subjected to radiation after a major trough has brought precipitation and colder air into the region. Ontario may fog in heavily the first night with ground fog which will dissipate during the day and form even thicker the next night. Meanwhile the fog will creep up the valley past Boise and Mt. Home to Gooding which is closer to the river. As the fog develops and intensifies, it will engulf both Boise and Mountain Home. The requirement for this situation to occur is a northwest to southwest wind. The diurnal wind shift from southwest to northwest occurs about 2100L, but the fog bank will often roll into Boise and Mt. Home between 0830 and 0900 in the morning especially on the second or third day. The best explanation is that the fog bank requires sufficient time to build up its source region where the Snake River moisture through evaporation and cold air is provided through drainage off the steep banks. In the morning, the exposed land at Boise and Mt. Home is heated up rapidly during the first hour or so after sunrise, thus creating thermal micro-scale low pressure. The resulting contrast in temperature and pressure causes the relatively high pressure over the river to drift towards the relatively low pressure near the base. This type of situation may occur for two to three days with uncanny certainty."

Another problem is the forecasting of surface winds. Forecasting the direction is relatively simple because of the channeling effect of the Snake River Valley. Strong

winds usually blow from a northwesterly or easterly direction toward the low pressure end of the valley. The possibility of strong surface winds should be considered when a front or attending strong pressure gradient is forecast for the valley or mature thunderstorm cells are predicted to move over the base. Strong winds of very short duration are associated with rapidly moving cold fronts that have little or no isobar packing in either air mass. Winds with this type front usually reach a peak of 25-30 knots and decrease rapidly after frontal passage. The channelling effect of the valley causes them to blow easterly before changing to westerly after a frontal passage.

Gusty surface winds with thunderstorms only occur when mature cells move over the base and then only for a few minutes. Peak gusts are normally near 35 knots from the west and northwest. Stronger cells may produce even higher gusts.

The strongest winds at MUO are associated with an intense pressure gradient along the Snake River Valley. This gradient may occur in two ways: first and least frequent, a strong ridge develops over the Rocky Mountains, and a deep low moves inland from the Pacific and maintains itself as it moves over the mountains. The low moves northwest around the ridge resulting in falling pressures in the local area. If the ridge to the east maintains itself, the pressure gradient in the valley strengthens and causes the local surface winds to become strong and gusty. The winds will blow from the east or southeast with peak gusts between 40 and 50 knots, and they persist only for five or six hours. As the low pressure area begins to move eastward, the gradient decreases, and the wind decreases to near normal. Second, and most frequent is just the opposite of the preceding discussion. Low pressure exists southeast and strong ridging from the Pacific dominates the Northwest. In this case, strength depends upon the development of a low to the southeast. In the first case, the most reasonable synoptic type is a B where rapid deepening has taken place in one particular trough that moved onshore in response to retrogression in the long wave pattern (rare over the western third of the U.S.). In the second case, any type D will create the proper conditions. Winds of 60 knots for 1-3 days are possible as a massive low builds up in western Utah to Colorado.

4. <u>SYNOPTIC TYPES AND FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction.

a. <u>Type A</u>: Southwesterly flow aloft parallel to weak

slow moving surface front over Washington. Trough is off West Coast with a weak 500 mb ridge over the Rockies. High at surface in eastern Utah. Low moving eastward through southern Canada.

(1) **Clouds:** Overcast multi-layered basic D category ceiling. Possible B if snow occurs which is more likely with this type than with others. Lowest ceiling occurs with frontal passage. Clearing is very slow thereafter.

(2) **Visibility:** Unlimited unless snow is forecast.

(3) **Precipitation:** Light precipitation except possibly moderate right at time of passage. Lasts 2-5 hours, rarely up to 10 hours but also rarely none.

(4) **Winds:** ESE 20-35 shifting to west 20-35 with passage dropping to 10 knots within hours.

b. **Type B:** Zonal flow with moderate upper air system moving across Washington and Oregon. Southwest polar jet near southern Idaho. Surface high in western Colorado.

(1) **Clouds:** Broken to overcast multi-layered middle ceilings lowering to 5,000 feet at passage of front. Do not forecast low ceilings (below 3,000 feet) unless moderate precipitation or snow is expected. Forecast scattered to broken high based cumulus after the front passes until the 500 mb trough passage when clearing will occur.

(2) **Visibility:** Unlimited unless snow is forecast (rare). Remember blowing snow will always occur at MUO when the temperature is below 32°F. Terrain is flat in the vicinity of the base.

(3) **Precipitation:** Light showers generally. Sometimes no precipitation will occur especially when cloud tops are less than 16,000 feet.

(4) **Winds:** E 10-20 knots ahead of front, W 20-35 gust at passage. W 10-15 behind front; possible gusts up to 40 knots just preceding passage of upper trough.

SUMMER TYPE B:

(1) **Clouds:** Scattered to broken cumulus - bases above 10,000 feet.

(2) **Visibility:** Unrestricted.

(3) **Precipitation:** Light showers, possible thunderstorms. If system is moderate to strong, moderate thunderstorms are a possibility.

(4) **Winds:** Wind out of SE 10, 15-20 Gust 35 after passage, decreasing after passage of upper trough.

c. Type B_1: Large-scale zonal configuration with strong northwest flow aloft. Polar jet over Washington. Moderate trough has passed station moving east. Ridge builds along West Coast or becomes quasi-stationary. Continental front lies along east side of Rockies. No frontal passage occurs at MUO.

(1) Scattered to broken cumulus in high D category from time of trough passage aloft for 12 hours - clear thereafter.

(2) Visibility: Unlimited unless snow showers forecast.

(3) Precipitation: Brief light snow or rain showers associated with convective activity.

(4) Winds: WNW 15-25 gusts 40 after passage of trough decreasing slowly for one to three days as the gradient weakens. Maximum gusts occur during the afternoon.

d. Type C_1: Strong high pressure over western Canada. cP front deep enough to move across the Continental Divide. In the upper air, northerly flow on west side of strong northeast-southwest oriented trough.

(1) Clouds: Clear unless cP front passes station. In that case, B category stratus for six hours.

(2) Visibility: Early morning fog likely. A category without precipitation; B category with precipitation.

(3) Precipitation: None normally. If weak front passes consider light snow or sleet.

(4) Winds: L/V tends to be E. Increase to 10 knots if front passes.

e. Type D: Digging trough aloft across southwest Oregon. Polar jet southern-central California swinging into Wyoming. Surface low tracks across central Utah. No Great Basin High.

(1) Clouds: Overcast multi-layered basic low D ceiling (B if snow and C if rain forecast) as upper low approaches station. D ceiling maintained until upper low reaches 112°W. General clearing thereafter.

(2) Unlimited in rain becoming 0-3 miles in snow.

(3) Precipitation: Light intermittent moderate rain changing to snow begins when upper low hits Oregon shore and ends as low passes SLC. This type produces heaviest precipitation of the season.

(4) Winds: E 10-15 backing to W 20-35 when pressure gradient vector is perpendicular to valley orientation.

f. Type E: Upper air flow is light westerly or northwesterly. Slow moving or quasi-stationary ridge dominates. Ridgeline lies east of 130°W but is west of station. Polar jet anticyclonic over southern Canada. A 500 mb high cell may be cut off over Washington. Regime usually lasts about two weeks.

GREAT BASIN HIGH JUST SOUTH OF MUO

(1) Clouds: Air must be moist to 850 mb, otherwise conditions will be clear. Weak inversion - A category fog breaking during the afternoon. Strong inversion and wind over 5 knots, fog will lift to B or C category stratus in afternoon. If overcast high or middle cloud moves in after fog formation, fog may last all day.

(2) Visibility: Category A in fog rises to B with stratus. D category visibility with C stratus.

(3) Precipitation: None Winds: L/V to 8 knots.

If ridgeline is 125-135°W and only a weak to moderate ridge exists (jet over or just east of station). Looks like a modification of B_1.

(1) Clouds: Scattered to middle broken above 10,000 feet with upper air impulses. Broken to overcast jet stream cirrus. Fog will occur with a light west or southwest wind assuming sufficient moisture available.

(2) Visibility: Unrestricted except in fog.

(3) Precipitation: None.

(4) Winds: L/V according to pressure pattern.

SUMMER TYPE E:

High over central Colorado and Wyoming. Thermal trough in Columbia Basin which may pass station as regime breaks down with minor trough aloft moving toward the Washington coast. (See TCM Forecast Guide).

(1) Clouds: Late afternoon cumulus.

(2) Visibility: Unrestricted.

(3) Precipitation: Rare thundershowers with trough passage.

(4) Winds: L/V according to pressure gradient.

5. SEASONAL FORECAST RULES:

WINTER: (December through February)

a. Do not forecast strong gusty winds from the north or south.

b. Do forecast winds 10 knots higher than ONO, BOI or BUR civilian TAFS with winter systems.

c. Forecast downslope tendency when the winds are from the southeast through northeast; upslope tendency from the west or northwest.

d. For a cP front to pass MUO, the 500 mb winds must be northeasterly, 25 knots or greater, at GFA and BOI.

e. When using the BOI raob, the average wind velocity at MUO will equal the average wind through the mixing layer. The maximum surface gust will equal the maximum wind in the mixing layer plus 5 knots.

f. Fog generally occurs only during the winter. Watch for light south and southwest winds combined with an inversion on the BOI raob.

g. Using the BOI raob (72681) and the LFM thickness prog, make a forecast of the 1,000-500 mb thickness at MUO. Forecast rain if the value is greater that 5,380 meters; snow if less than 5,380.

<u>SUMMER</u>: (June through August)

a. If a thermal trough passage is expected and mP air to the west has sufficient moisture, the trough will likely contain a squall-line and resemble a frontal passage.

b. Do not forecast ceilings below 10,000 feet as they rarely occur for other than a short time and are nearly impossible to time.

c. Fog and stratus rarely ever occur during summer and should not be forecast.

<u>SPRING AND FALL</u>: (May and September through November)

a. Spring is an extension of winter patterns so expect a decrease in the frequency of low ceilings and visibility and expect precipitation to become more convective. Frontal passages are generally weaker and more infrequent.

b. Fall is an extension of summer patterns except that frontal passages are more frequent. Expect an increase if subsidence in the mean and the possibility of occasional fog and stratus.

HILL AFB (HIF) FORECAST GUIDE

1. UNITS SUPPORTED: 1550th ATW (helicopters and C-130), 508th ARW (AFR F-105), 6514th Test Sq (drone Testing), Ogden ALC (F-4 Flight Testing), LogAir, UANG Salt Lake (KC-97). Special amendment criteria for the 1550th - 700 feet and/or 2 miles (day operations) and 1500 feet and/or 3 miles (night operations). Flight test minimums are 5000 feet and 5 miles. Ogden ALC minimums 1500 feet and/or 3 miles.

2. PHYSICAL DESCRIPTION AND LOCATION: Hill Air Force Base is five miles south of the City of Ogden, Utah at 4,785 feet MSL. It lies only 5 miles from the very steep rising Wasatch Mountains to the east. This range extends in a gentle arc from the northern border of Utah to the center of the state and forming a "1" with the Uinta mountains which run eastward from Kamas (east of SLC) to the eastern border of Utah. These ranges are two of the most definitive mountain barriers in the contiguous United States with peaks over 12,000 feet in height rising from surrounding terrain of about 4,000 feet. The mouth of the infamous Weber Canyon lies just four and one-half miles to the east of the base and is the underlying cause of strong easterly winds at Hill. To the west lies the Great Salt Lake Basin which extends northward to Idaho and westward to Nevada. Another range, the Oquirrhs, lie on the south side of the Great Salt Lake 35 miles south-southwest of the base. The Salt Lake Valley extends southward from the lake between the Oquirrh and the Wasatch and contains the metropolitan area of Salt Lake City. Great Salt Lake constitutes 1600 square miles and an even larger area of salt flats which are sometimes water covered. The primary runway at HIF is 14-32 and has dual instrumentation. The climate is semi-arid continental.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: First, the Desert Region of the local area which is e especially subject to drying out is probably the most important factor in the discussion of HIF weather. The low hills in the Basin do not prevent large quantities of dust from being picked up by strong gradient winds from the southwest and mixing the dust as high as 20,000 feet. although the visibility is noticeably reduced, this dust rarely becomes a hazard to aviation. The major air pollution sources are refineris 15 miles south of the base and ore smelters in the area west of Salt Lake City. When a strong inversion is present, especially during

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Castle Rock
EVANSTON
PROVO
Fruitland
HL
JL

the winter when a strong PB high dominates, conditions can drop below 3 miles. In summer, early morning visibility can be five miles, but pollutants are quickly mixed out.

Second, the Wasatch Mountains to the east of the base significantly affect the weather patterns at Hill AFB. These mountains provide the necessary orographic lifting to initiate cloud development. In many cases, low level moisture introduced into the area is forced aloft thereby forming clouds. As the influx of moisture increases, the cloud deck begins to build back from the mountains over the base. The net effect is category D ceilings, while the surrounding cities have E category ceilings. These mountains are also infamous for turbulence. Normal zonal flow will produce turbulence on the east slopes of the mountains throughout the year. During the winter season, however, when the Great Basin High dominates the area and easterly winds prevail, Hill will be affected by the turbulence generated out of the mountain wave (SEE COS Forecast Guide for complete description of this phenomenon). Such turbulence rapidly increases to the moderate or severe categories when associated with the morning drainage winds.

b. Transient Controls: Upper air closed lows are very common around HIF as the station lies close to the digging track of the classical "Colorado Low" pattern. Closed lows may cut off in the Great Basin area in the base of a major trough over the central U.S. or under a ridge which extends into British Columbia. Occasionally, these lows are simply transitory and do not provide thickness support to analyze a front on the surface. These lows occur most often in April and October - least often in mid-summer and mid-winter. They produce short periods of heavy precipitation to none at all. The cessation of such rainfall does not occur with the passage of the pressure trough. It ceases with the passage of the 700 mb thermal trough.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Southwesterly flow over Washington with a ridge over the Rockies. Great Basin High cell located in eastern Utah. Forecast no significant clouds with weak easterly winds on the surface. If winds are southerly, smog may become a problem as the Polar Basin (PB) air mass stagnates in the Salt Lake Valley. Such periods can last from several days to a month or more.

b. Type B: Zonal configuration. Moving troughs of moderate intensity. Moderate jet across Washington or Oregon. Transient troughs not digging as they move into Rockies.

Great Basin High position variable but most persistent in western Colorado. Weak frontal passages at HIF and most probably aloft over PB air in the Salt Lake Valley. Forecast basically nothing with light occasionally moderate southerly winds. E category ceilings occur with weak frontal passages. Snow showers are likely in the mountains. Smog remains a problem as front is too weak to displace stagnating PB air mass.

c. Type B_1: Large scale zonal configuration. Strong northwest flow aloft behind transient troughs. Troughs may have some digging tendency moving toward the Rockies. Ridge builds over West Coast or becomes quasi-stationary. Weather may appear like a squall-line on radar as front approaches.

(1) Clouds: Broken middle and high clouds are in advance of fronts, tops 200-250. Heavy cumulus over mountains may build as front arrives and then build back over station. Clouds remain until the 700 mb thermal trough passes. D category ceilings are likely with this type.

(2) Visibility: Unrestricted unless showers occur into a strong low-level inversion.

(3) Precipitation: Showers beginning one hour after frontal passage and continuing intermittently until 700 mb thermal trough passage. Unless front is well supported aloft, there may not be any precipitation.

(4) Winds: SE 10-15 shifting to NW 15-25. Winds drop off rapidly after upper trough passage.

(5) Icing: Light to moderate mixed in clouds over mountains.

d. Type C_1: Strong high pressure over western Canada southeast toward east side of Continental Divide. cP·cA air deep enough to move across Divide. Northerly flow aloft over area on west side of deep trough over Plains.

e. Type D: Digging trough aloft across southwest Oregon. Polar jet through southern-central California as surface low tracks across central Utah. No Great Basin High at all. Complete change of air mass in Salt Lake area guaranteed. Pattern may produce heaviest areal precipitation of year.

(1) Clouds: Heavy multi-layered stratiform 300-350 in advance of system. Heavy cumulus and CB activity after frontal wave passes until 700 mb thermal trough is east of Wasatch Mountains. D category ceilings will rapidly deteriorate to B and remain B until precipitation is forecast to stop. D will persist until upper low reaches central Colorado or continue if the 700 mb thermal trough remains in the area.

(2) Visibility: Unrestricted at first. Deteriorates to D or C in rain but definitely B in snow (A if snow is moderate or greater).

(3) Precipitation: Mostly snow; begins when upper air low reaches north-central California. It may become heavy. Rain is less common during the winter. If winds veer, snow may change to rain.

(4) Winds: Unsteady E or SE winds back or veer to northwest depending on track of surface low. 10-15 initially may increase to 20-30 from northwest after passage. Winds rapidly drop after upper air trough goes by.

(5) Icing: Moderate rime in layered clouds to heavy mixed in vicinity of upper system.

f. Type E: Major trough over central U.S. with ridge along West Coast. Polar jet is east of station with northwesterly flow. (Trough in central U.S. is not elongated southwest over southern Rockies). Basin High is strong right over the station. Intrusion of cP air not likely, although some drainage possible.

(1) Clouds: High thin scattered to broken.

(2) Visibility: Unrestricted unless proper conditions are met for radiation fog.

(3) Precipitation: None. (4) Winds: L/V less than 8 kt.

g. Type E_1: When a strong warm ridge builds into Washington and British Columbia and cuts off (February - April), a closed low is apt to develop over the southern Great Basin producing an extensive area of convective type precipitation. Minor upper waves move through the HIF area.

(1) Clouds: Basic D ceilings ahead of waves becoming B in showers (snow in spring - rain in fall). C ceilings are possible if precipitation is very light. When the regime is in progress, E category ceilings or no ceiling will occur for short (probably unforecastable) periods.

(2) Visibility: Unrestricted except in showers.

(3) Precipitation: Showers in spurts.

(4) Winds: S or E - generally light except in the vicinity of convective activity.

(5) Icing: Light to moderate mixed.

5. SEASONAL FORECAST RULES:

a. Do not forecast D category ceilings more than 100 miles in advance of B type frontal systems. Hold it in later after passage, however, than would normally be expected (retarding influence of mountains).

b. Weber Canyon winds can occur during all seasons but are the most difficult to forecast during winter and spring. The canyon is a drainage channel for 6,000 square miles of Wyoming lying at about seven to eight thousand feet MSL. Both drainage (Katabatic action) and pressure gradient can produce these winds. A combination of the two will produce gusts in excess of 40 knots. Cloud cover will significantly reduce any drainage winds.

c. Snow versus rain: If the 2,000 foot wet-bulb temperature is less than $0^{\circ}C$, the 700 mb wet-bulb temperature is less than $-5^{\circ}C$, the $T-T_d$ is equal or less than $6^{\circ}C$ and the vertical velocity is more than 2 mb/hr at both 850 and 700 mb, then any precipitation reaching the ground will be snow.

d. It is unwise to forecast C category ceilings at HIF. Normally they will be either D or B in precipitation.

SPRING

a. Heavy thunderstorms may accompany winter-type B_1 frontal passages (not air mass).

b. Cutoff lows or cold pools have a maximum during April.

SUMMER

a. Do not forecast D ceilings in advance of a front at HIF (cT air mass predominates).

b. Do not forecast thunderstorms at HIF unless moist air from the Gulf of Mexico (or Baja) has clearly reached the area.

FALL

a. Summer-type thunderstorms are extremely rare in September and October.

b. Expect the first winter storm toward the first of October.

c. Cold pools aloft have a maximum during October.

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DUGWAY PROVING GROUND - MICHEAL AAF (DPG) FORECAST GUIDE

1. UNITS SUPPORTED: Army Test Operations. (Aviation not significant). Significant forecast parameters are precipitation of any type, gradient level wind forecast and sustained gradient winds from the south. Micro-meteorology is an important function at DPG.

2. PHYSICAL DESCRIPTION AND LOCATION: Dugway Proving Ground lies 65 miles southwest of Salt Lake City at an elevation of 4,300 - 4,600 feet MSL. It is bordered on three sides by mountains and is open to the Great Salt Lake Desert to the northwest. The highest points in the immediate vicinity are Deseret Peak 25 miles to the northeast and Granite Peak 20 miles west. The ground is clay and sand. Snow or rain can barely penetrate into the ground. Standing water is present on the salt flats to the northwest during periods of rain and the spring melting season. Sand dunes lie to the northeast. Vegetation is very sparse, and the climate is arid. Synoptic regimes are similar to those for HIF. Extent of cloud patterns associated with active systems is much less at DPG than at HIF, primarily due to the longer distance from the Wasatch Mountain Range.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The greatest effect orography has at DPG is on the windflow. Strong pressure gradients at the surface are disrupted by the mountains causing the wind to flow more across the isobars. The DPG area lies in a V-shaped valley which slopes upward to the southeast. Without strong synoptic influence, the daytime wind flow is up the valley and down the valley at night (lighter). When accompanied by a northwest gradient wind flow, 15-20 knots can be expected on the surface.

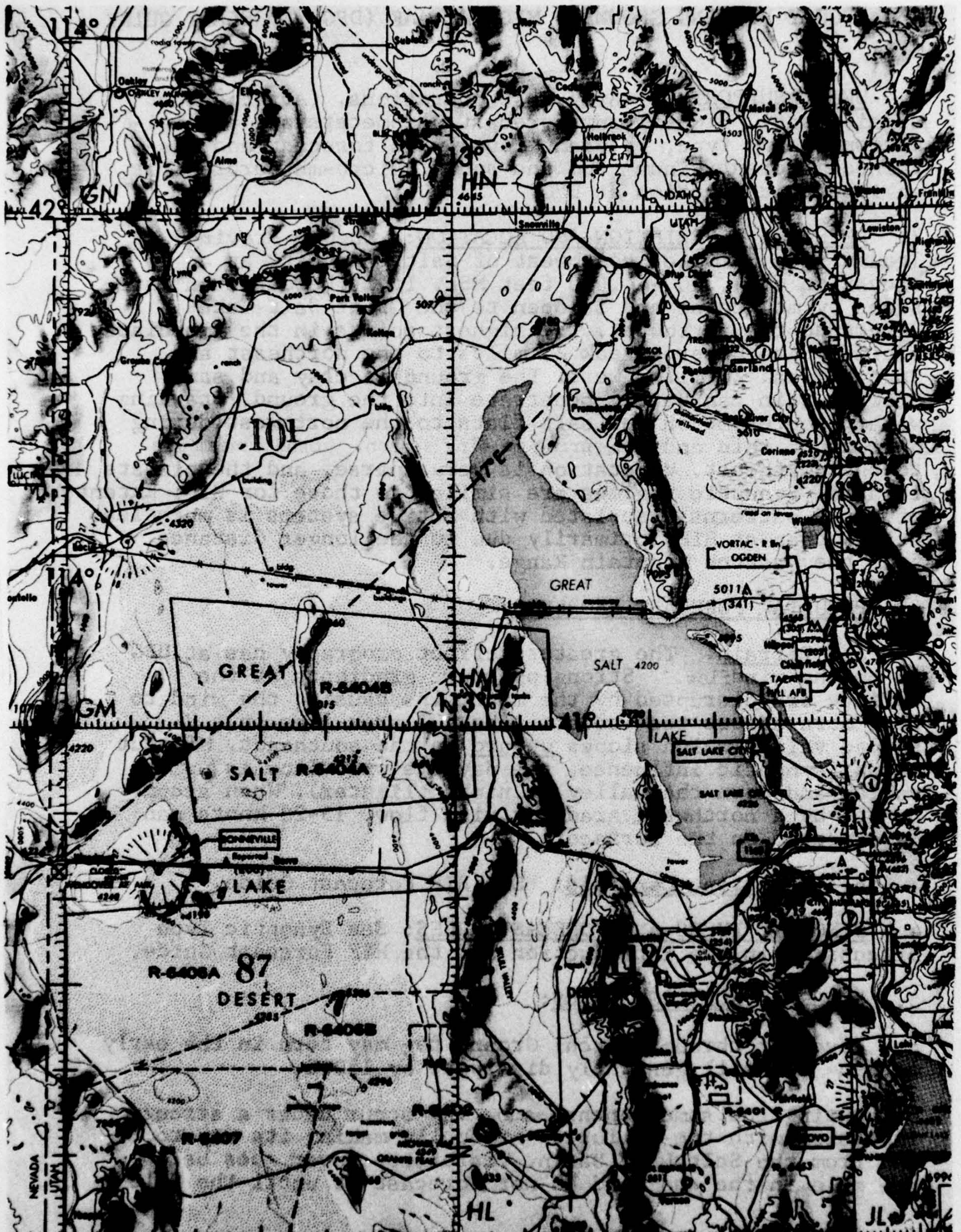
b. Transient Controls: See HIF Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and the HIF Forecast Guide.

5. SEASONAL FORECAST RULES:

a. November through March: Ground fog may form in the early morning but will generally dissipate by 1500Z.

b. During the same months, smog may occur under a strong inversion with the pollution gradually making its way to DPG from the Salt Lake Basin. Visibility never goes below one mile in the smog and do not forecast it until the Salt



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BONNEVILLE
HILL AFB
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HN
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HL
JL
101
87
Snowville
Park Valley
Promontory
Corinne
NEVADA

Lake Valley stations are completely covered first.

c. Forecast snow at DPG by calculating the 850 and 700 mb thickness off the NMC 24 hour progs. If the value is progged to be greater than 1,550 meters and the 700 mb temperature is less than -6^{o}C. (and precipitation is forecast), then it will be in the form of snow.

d. <u>Dust</u>: With strong gusty surface winds from the south (pre-frontal), a collection of sand and dirt collects on the south sides of vegetated areas. When gusty post-frontal winds of greater than 30 knots occur, this collection of sand and dirt will be picked up and removed from these areas within a few minutes of frontal passage and cause a reduction in visibility to less than 5/16ths of a mile for a 15 or 30 minute period.

REGION 2

CENTRAL CALIFORNIA FORECAST GUIDES

BEALE AFB (BAB) FORECAST GUIDE

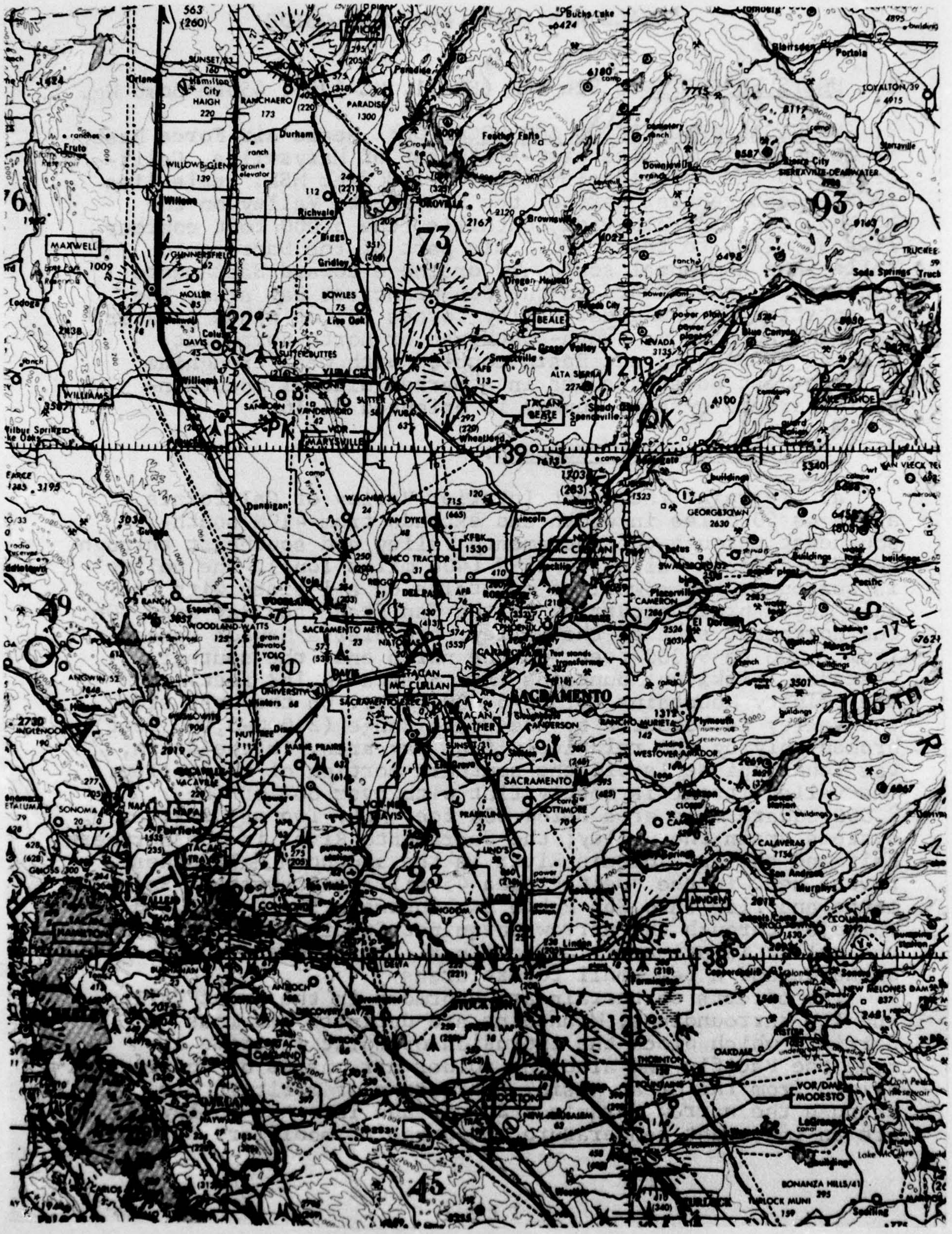
1. UNITS SUPPORTED: 9th SRW (SR-71, KC-135), 456th Bomb Wg.

2. PHYSICAL DESCRIPTION AND LOCATION: Beale Air Force Base is located eight miles east-southeast of Marysville, California and has a field elevation of 113 feet MSL. Beale lies in the east-central part of the Sacramento Valley on the edge of the Sierra Nevada foothills (the 5,000 foot contour lies 35 miles to the east). This part of the Sacramento Valley has a gradual southward drainage toward Sacramento and then southwestward to the San Francisco Bay area. The orientation of the Great Valley forces 80% of winds greater than 10 knots to be south-southeast or north-northwest. Ridging over the Great Basin coupled with weak troughing off the West Coast results in a marked diurnal mountain-valley breeze system. Runway is oriented 34-16.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The Great Interior Valley of California averages 50 miles in width and extends from 41°N south-southeast through the Sacramento Valley and southeast through the San Joaquin Valley to 35°N (400 miles long). The valley is surrounded by a wall of mountains on all sides with the only major break occurring in the San Francisco Bay area. On the northeast side of the valley, the Sierra Nevada ranges from 7,000 to 9,000 feet; on the north end, the southern Cascades, Siskiyou Mountains (Mt. Shasta 14,162 feet) and the Trinity Mountains (6,000-8,000 feet). On the west side, the valley is bordered by the Coast Range (2,000-3,000 feet) broken only by the relatively flat Bay area. To the south, the Tehachapi seals off the southern portion of the valley. The valley itself is mostly flat with over 80% of the 2,000 square mile area below 300 feet MSL. Two major river systems drain the valley; the Sacramento River in the northern half and the San Joaquin River in the southern half. These rivers meet in the "Delta" area 45 miles southwest of Sacramento and flow into San Pablo Bay (between San Rafael and Vallejo) through the narrow Carquinez Strait. Vegetation in the valley is primarily agricultural crops, grasslands, orchards and a few small forest areas.

The effects of terrain are enormous in the Great Valley and its surroundings. Mountains are definite air mass barriers which block the intrusion of moist maritime air from the Pacific and also the colder air masses of continental origin from the Great Basin. Intrusions of maritime air through the narrow Carquinez Strait and into the valley are an important temperature and dewpoint modifier. Stratus



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Paradise
Durham
Richvale
Gridley
Live Oak
Yuba City
Grass Valley
Auburn
Lincoln
Placerville
Georgetown
Davis
Vacaville
Sonoma
Stockton
Oakdale
Turlock
Bonanza Hills
Truckee
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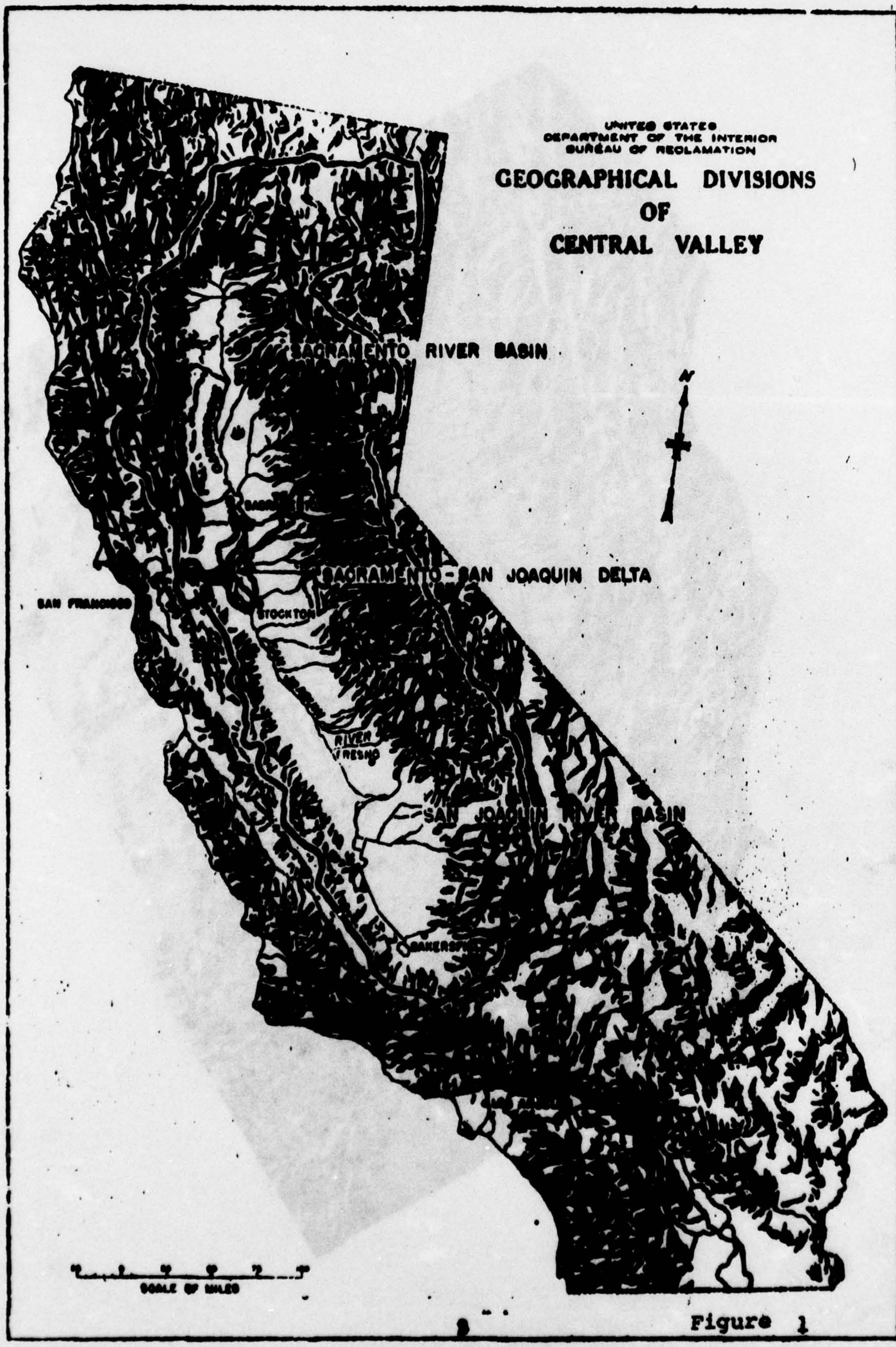
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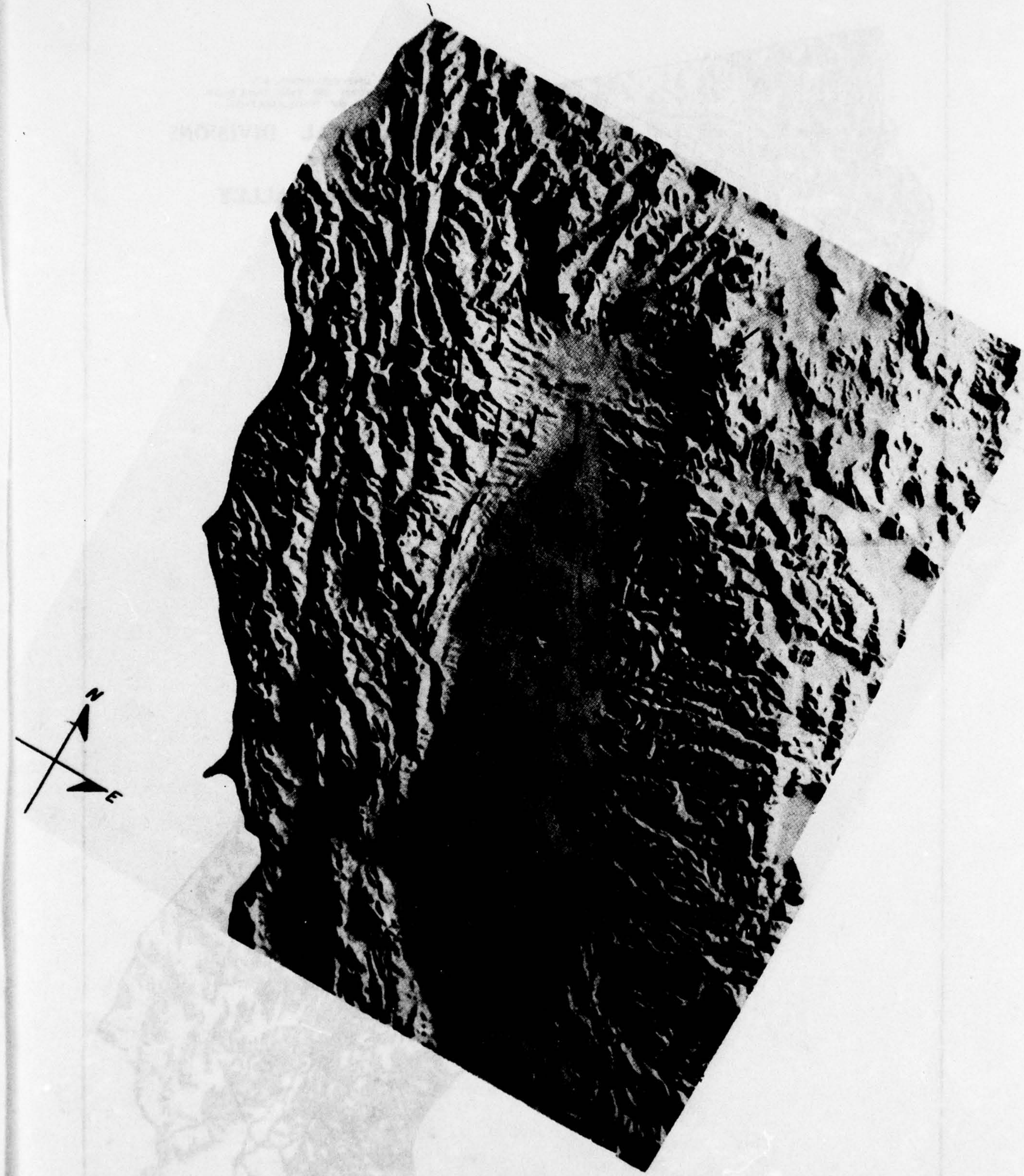
Figure 1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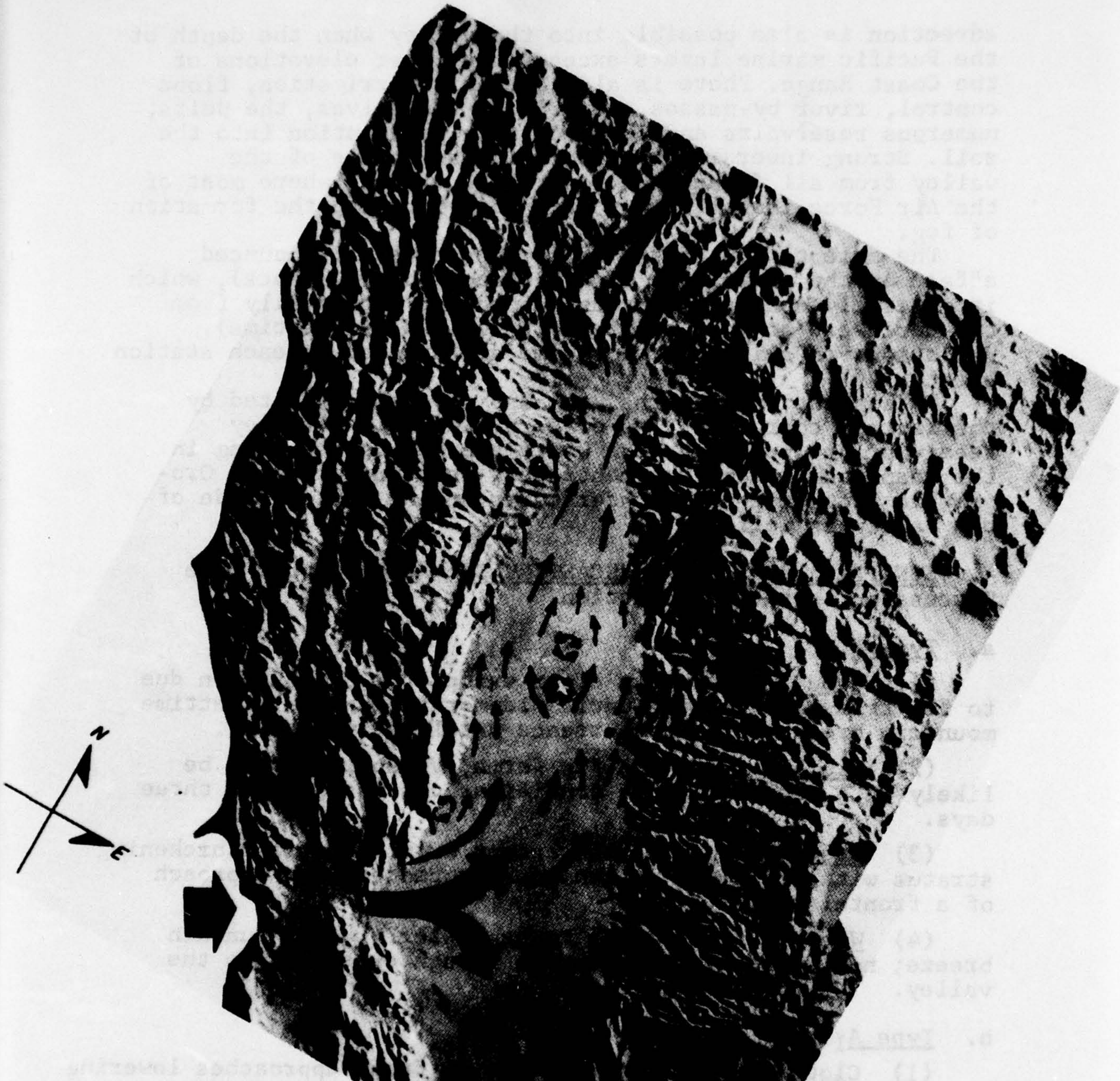
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advection is also possible into the valley when the depth of the Pacific marine layers exceeds the lower elevations of the Coast Range. There is also extensive irrigation, flood control, river by-passes, the rivers themselves, the Delta, numerous reservoirs and poor moisture percolation into the soil. Strong inversions and the sloping nature of the valley from all directions toward the middle, where most of the Air Force installations are, contribute to the formation of fog.

The orientation of the valley has a very pronounced effect on the prevailing wind (greater than 10 knots), which is generally southeast through south and secondarily from the northwest at most stations (about 80% of the time). Variations in this general regime are treated in each station section.

Precipitation patterns are also severely affected by the terrain character. The eastern side of the valley receives more precipitation where the air is ascending in the mean than toward the central or western portions. Orographic lift triggers thunderstorms on the eastern side of the valley as well.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A:

(1) Clouds: Normally clear except for obscuration due to fog from late evening until mid-morning unless nighttime mountain breeze delays occurrence until early morning.

(2) Visibility: When fog forms, visibility will be likely in A category. Such conditions can last two or three days.

(3) Precipitation: None except drizzle out of thickening stratus with rising inversion not associated with approach of a frontal system.

(4) Winds: L/V - tends to be easterly with mountain breeze; northwest if weak thermal trough extends into the valley.

b. Type A_1:

(1) Clouds: Increasing layers as front approaches lowering to D ceiling when rain begins about 300 miles in advance of surface position. Ceiling will likely drop to C with frontal passage and steady moderate precipitation. (Looks like warm front precipitation pattern).

(2) Visibility: Forecast D category when rain begins and perhaps C at time of frontal passage. If a low-level inversion exists, visibility can decrease to less than one mile in fog and haze especially if smoke from Sacramento is present in the area.

(3) Precipitation: Heaviest precipitation occurs within two hours of passage; becomes showery after passage ending entirely with upper trough passage.

(4) Winds: SE with gusts from 20-40 knots proportional to pressure gradient in advance of moderate front. Slight shift to SW with passage. Winds become light after passage of upper trough.

c. Type B:

(1) Clouds: Thin cirrus except scattered to broken middle clouds with upper trough (not category D).

(2) Visibility: Ground fog possible early morning, but rare. At worst, six miles in haze morning and evening.

(3) Precipitation: None.

(4) Winds: NW 10-15. SE 10-20 ahead of any approaching upper trough.

SUMMER TYPE B:

(1) Clouds: Isolated CB over Sierra with upper trough.

(2) Visibility: Five miles in smoke and haze worst.

(3) Precipitation: None.

(4) Winds: SE-S strong gusts ahead of trough; NW 10-15 otherwise.

d. Type B_1:

(1) Clouds: Broken to overcast middle (E category) to intermittent D; clearing with frontal passage especially if at night. If upper trough remains west of station, cumulus and CB will develop with thunderstorms likely of the Sierra.

(2) Visibility: D category in intermittent showers. Early morning ground fog is possible if upper trough does not pass.

(3) Precipitation: Showers; heaviest in mountains east of the base and in late afternoon or evening.

(4) Winds: SE 10-15. Shift to NW 10-15 if upper trough passes. If it does not, forecast SW 5-10 knots, 10-15 in afternoon until trough does pass.

e. Type B_2:

(1) Clouds: Multi-layered to 40,000 feet with large ceiling variations between waves. Forecast D continually based on persistence until the regime has a definite break. Expect temporary B ceilings as waves pass BAB area.

(2) Visibility: C and B category when waves pass. (Rarely ever A). Poor visibility periods normally last about 12 hours.

(3) Precipitation: Continuous light precipitation, intermittent rain and showers with 4-8 hour periods of heavy rain with waves. Twelve inches over a 4 day period have occurred with this regime.

(4) Winds: Back and forth from SE gusts 20-40 to NW less than 10, then backing again to SE in advance of next system. If cold pool remains offshore, shift will be to the southwest and decreasing.

f. Type C: No clouds or precipitation with this type. Unrestricted visibility and wind N-NE at 10 knots.

g. Type C_1:

(1) Layered middle clouds (E category) possible intermittent D category in showers. Middle clouds persist between systems. Thunderstorms may form on Coast Range and move over station persisting as late as midnight.

(2) Visibility: Intermittent D in showers; can lower to less than one mile in ground fog next morning after showers occur.

(3) Precipitation: Showers and thundershowers as troughs pass. Maximum amounts occur to east of the base.

(4) Winds: SE-S 10 knots at night. S-SW 10-15 afternoons with variable gusting in showers.

h. Type C_2:

(1) Clouds: Multi-layered in vicinity of fronts, rarely below a low D. Broken high D has tendency to persist behind a front of this type. Watch for thunderstorms in the spring, especially if upper air trough decides to move through.

(2) Visibility: Generally D in showers.

(3) Precipitation: Light to moderate rain in vicinity of front; otherwise showery remaining as long as cold pool remains off coast.

(4) Winds: SE 10-15, shifting to SW at 10 knots - may veer somewhat further west during afternoons. Shift to NW will only occur after trough passage.

(5) Summer: Same general pattern except E category ceilings with intermittent C/D in thundershowers or rainshowers. Bands of CBs moving from the south are more important in summer with this type.

i. Type D, D_1:

(1) Clouds: D - Low D ceilings with frontal passage.

D_1 - none.

(2) Visibility: D - D category in showers.

D_1 - unrestricted.

(3) Precipitation: D - showers late in season following the front.

D_1 - none.

(4) Winds: SE and gusty shifting to NW 10-20. Maximum gust within five knots of Medford (Ore.) 5,000 foot wind at 1200Z. Winds gradually decrease each day after regime starts.

j. Type D_a:

(1) Clouds: Occasionally broken E category middle clouds.

(2) Visibility: Unrestricted.

(3) Precipitation: None.

(4) Winds: NE gusts to 35 knots if Great Basin High is evident above 8,000 feet.

(5) Turbulence: Likely to 10,000 feet.

(6) Summer: Clouds consist of CB over the Sierra. There will be no precipitation unless the spreading of CBs causes showers. Winds in the summer are NE 10-20 gusts to 40 the first day with lowest wind speed at sunrise. Decreases each day the regime persists. Turbulence is just as likely as in winter.

k. Type E:

(1) Clouds: Low stratus possible during day in B category. A category at night if fog forms; increases chances if regime persists.

(2) Visibility: A category to C or D category afternoon if fog present.

(3) Precipitation: None except light drizzle associated with stratus.

(4) Winds: L/V to SE afternoon 5-10.

(5) Summer: No weather at all with this type. Winds are SSE or NNW 5-10.

l. Type E_1: In winter this type is almost the same as D_a. In summer, there is no significant weather except gusty northeast winds.

5. <u>SEASONAL FORECAST RULES</u>:

<u>WINTER</u>

a. Low-level intrusions of maritime air should not be forecast unless a relatively strong front allows moisture in depth to penetrate the Great Valley.

b. When a maritime inversion (look at 72493 raob, Oakland) exceeds 950 mb (2,000 feet) , and pressure differentials indicate inflow, stratus and/or fog are a definite possibility.

c. Light southwesterly flow will permit upslope fog and stratus regimes, and there are sufficient moisture sources in the area for radiation fog. To forecast onset time, strength of the mountain or valley breeze must be forecast.

d. Subsiding air over the mountains from the north and east when the Great Basin High is strong strengthens the inversion making a stratus/fog regime worse.

e. Once a stratus/fog regime is in being, it normally takes a cold or occluded front to clean it out. (Forecast low pre-frontal visibility).

f. If the surface wind does not shift to northwest (only to southwest or west-southwest) and back again to the southeast following the frontal passage, a cold pool probably exists or is forming.

g. If the stability 850-500 mb falls to less than +3, expect thunderstorms in the vicinity of the base (applies to spring and fall also).

h. When cP air crosses the mountains, as with Type D_a, gusts will last up to eight hours and may repeat the following afternoon but <u>never</u> the third day.

i. Do not expect to see roll cloud or ACSL even though turbulence is forecast.

j. In Type A patterns, the fog and stratus regime may persist with minor breaks until the warm Pacific Ridge collapses, as long as five weeks at a time.

k. Initial formation of ground fog usually occurs on the third day of a Type A regime.

l. If a layer of moisture is advected into the Sacramento Valley from the Bay area, insolation will not break it during the afternoons for several days.

m. Ephemeral fog - a mountain breeze of one to three knots is sufficient to keep ground fog west of the area, but when a valley breeze begins shortly after 1600Z, expect the fog to move over the base.

n. Gusty northerly winds never exceed 35 knots.

O. Winds shift to southwest with frontal passage and to the northwest with trough passage. (Note exceptions in Section 4).

<u>SUMMER</u>:

a. Rain is very rare in the summer, and generally all of this occurs from thunderstorms.

b. Location of the thermal trough with respect to BAB will usually prevent penetration of moist air from the coast this far. Forecast winds at SUU <u>must</u> exceed 15 knots out of the southwest.

c. Stratus and fog are very rare at BAB during the summer.

d. With Type B regimes, the strength of gusts will approach that of the 5,000 foot wind over central California.

e. In the E_1 regime, strongest winds occur during mid to late afternoon after the polar jet is established overhead.

TRAVIS AFB (SUU) FORECAST GUIDE

1. UNITS SUPPORTED: 60th MAW (C-5, C-141), 916th ARS (KC-135), Contract LogAir (C-130). Crosswinds are a problem due to the runway orientation (greater than 25 knot component).

2. PHYSICAL DESCRIPTION AND LOCATION: Travis Air Force Base lies 45 miles northeast of San Francisco proper and 30 miles southwest of Sacramento at an elevation of 62 feet MSL. The base lies at the western edge of the Sacramento Valley about eight miles northwest of Suisun Bay or the eastern edge of the Carquinez Strait. Its relationship to the Coast Range is a little different than the interior Great Valley stations and bears a little more description. The western border of the Great Valley is the Coast Range which extends in a southeasterly direction north of the Sacramento River (which runs into Suisun Bay). The range then continues southward below the river. Twenty-five miles south of the field is Mt. Diablo (3925) and to the northeast the Coast Range reaches elevations of 2,800 feet within 12 miles. To the north and east, rolling terrain merges with the Sacramento Valley within 15 miles east of the base. The Coast Range peaks lower to about 1,500 feet on either side of the Carquinez Strait, the junction between Suisun and San Pablo Bays. This is the only major break in the mountain barrier surrounding the Great Valley resulting in a modified maritime climate for Travis and adjacent areas. The Coast Range to the west is high enough to prevent the advection of summer stratus over the field except when the inversion gets too high. During the winter months, the adjacent bodies of water provide a moisture source for advection and radiation fog at SUU. The major source of air pollution is an industrial complex 20 miles south of the field. Urban areas and summer grass fires provide other sources. The runway runs 21-03.

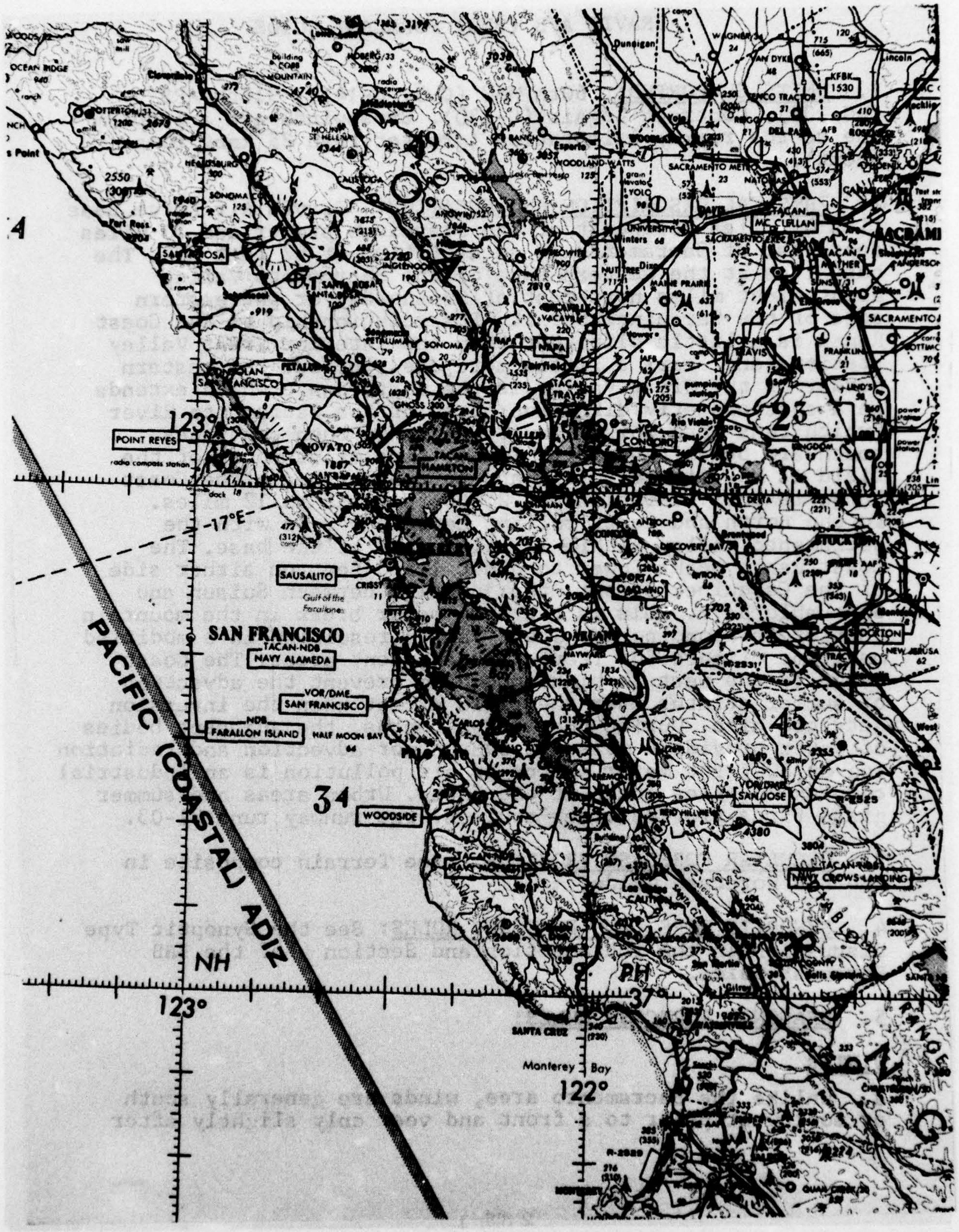
3. PECULIAR FORECAST PROBLEMS: See Terrain composite in the BAB Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See the Synoptic Type Discussion in the Introduction and Section 4 of the BAB Forecast Guide.

5. SEASONAL FORECAST RULES:

WINTER

a. Unlike the Sacramento area, winds are generally south or southwest prior to a front and veer only slightly after



SANTA ROSA
SAN FRANCISCO
POINT REYES
radio compass station
NOVATO
HAMILTON
-17°E-
SAUSALITO
Gulf of the Farallones
SAN FRANCISCO
TACAN-NDB
NAVY ALAMEDA
VOR/DME
SAN FRANCISCO
NDB
FARALLON ISLAND
HALF MOON BAY
34
WOODSIDE
PACIFIC (COASTAL) ADIZ
NH
123°
PH
122°
Monterey Bay
SANTA CRUZ
NAPA
TRAVIS
CONCORD
OAKLAND
STOCKTON
23
45
SAN JOSE
TACAN-NDB
NAVY CROWS LANDING
MC CLELLAN
SACRAMENTO METRO
SACRAMENTO
KFBK
1530

passage. A strong shift of wind to the northwest is unlikely even when the front comes from that direction as in Type C or D fronts.

b. After an A or B type frontal passage without passage of the upper trough, drizzle can hang in at SUU longer, whereas showery precipitation is more likely in the Sacramento area.

c. Watch out for gusty winds right across the runway when a strong surface low approaches SUU between 35-40°N. Gusty winds from the north occur when a high is over the Pacific Northwest with a trough to the south (Types D and E).

d. To make a forecast within the next 24 hours for rain, all of the following criteria must be met (works equally well at all central California stations.)

(1) The MFR (72597) 500 mb height is below 5690 meters.

(2) The MFR wind direction is not 320-360-040° at 500 mb.

(3) The ACV surface pressure is below 1025 mb.

(4) SFO surface pressure is higher than ACV or no less than 1 mb below.

NOTE: This latter rule will not work for fronts and cold pools approaching from the southwest (such as Type C_2). To take care of this latter condition, make a forecast of the vorticity value that will be over the station in 24 hours. Go about 4 degrees upstream as follows:

(1) 8-10 High broken cirrus.

(2) 10-12 AC, R-, R--

(3) 12-14 Broken D ceilings, scattered showers.

(4) 14-16 Heavy cumulus, CB, moderate showers.

(5) 16+ Thundershowers.

e. Most fog occurs (91%) when the wind is calm or with light northeasterly component.

f. North winds: If the north wind components are 25 knots or greater from the surface to 15,000 feet, forecast the maximum gust to 40 knots by multiplying 10 times the pressure gradient RBL to SAC. If winds aloft are greater than 25 knots, add a percentage to the forty knot forecast for the period 0900L to 1400L. Expect 10-15 knots in the evening and less at night. (Primarily a winter phenomenon.)

SUMMER

a. Southwesterly winds are the most common and reach 28 knots in the afternoons of many days. As the sea breeze kicks in, higher gusts are possible but rare.

b. If the base of the OAK inversion is expected to be between 1,500 and 2,500 feet, forecast the maximum gust to 35 knots by multiplying 10 times the pressure gradient from SFO to SAC. If a surface front or upper trough is expected to be within 300 nautical miles upstream and a strong pressure gradient from SFO to RBL is expected, forecast the inversion to lift and the winds to increase. If the inversion is below this level, forecast less than 25 knots.

McCLELLAN AFB (MCC) FORECAST GUIDE

1. UNITS SUPPORTED: 9th Wea Wg (RC-130), 552nd AEW Gp, 41st Rescue Sq (HH-3, HC-130), Heavy Transient Traffic. Special amendment criteria of 400 feet and/or 1 mile and 100 feet and/or ¼ mile. Air Logistics Center. 940th TAG (AFRES)

2. PHYSICAL DESCRIPTION AND LOCATION: McClellan Air Force Base is located ten miles north-northeast of central Sacramento, California at an elevation of 76 feet above sea level and approximately 60 miles north-northeast of the center of the Great Valley. The immediate surroundings of the base are mostly urban with a park to the south and grasslands to the north. Major air pollution sources are rice straw burning in late fall in the sectors southwest through north, grass fires just north of the base and urban/industrial effluent from the greater Sacramento area. All this pollution may reduce visibility some. Runway is oriented 34-16.

3. PECULIAR FORECAST PROBLEMS: See BAB Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of BAB Forecast Guide.

5. SEASONAL FORECAST RULES:

WINTER:

a. Smoke is a real problem at MCC during late October and November with a strong inversion (Type A) present. Visibility may drop to C or B categories in late afternoon due to rice burning. It takes a strong wind or steady rain to clear this up.

b. Ground fog occurs in the river lowland but is usually shallow and does not often move over the base.

c. Persistent stratus/fog regimes occur when an mP high replaces stagnating PB or cP high cell in the Great Basin or Columbia Basin.

d. Max winds occur at MCC with a Type A_1 system where the low center moves close to BAB.

SUMMER:

a. In the spring, moisture advected through the Carquinez Strait will bring stratus (C category) to the Sacramento area for a few hours.

MAXWELL
WILLIAMS
Williams
Willows
Orland
Hamilton City
Durham
Richvale
Biggs
Gridley
Live Oak
Paradise
PARADISE
Oroville
OROVILLE
Feather Falls
Brownsville
Downieville
Sierra City
Portola
BEALE
Grass Valley
NEVADA
Blue Canyon
Soda Springs
LAKE TAHOE
YUBA CITY
SUTTER
MARYSVILLE
Wheatland
Lincoln
Auburn
GEORGETOWN
Placerville
CAMERON
El Dorado
KFBK
1530
WOODLAND
Woodland
Esparto
DAVIS
Davis
Winters
Dixon
SACRAMENTO METRO
SACRAMENTO EXEC
MC CLELLAN
SACRAMENTO
TACAN MATHER
RANCHO MURIETA
Plymouth
WESTOVER-AMADOR
Jackson
CALAVERAS
San Andreas
Murphys
SONOMA
PETALUMA
NAPA
Fairfield
TRAVIS
CONCORD
HAMILTON
Antioch
DISCOVERY BAY
Brentwood
STOCKTON
OAKLAND
HAYWARD
SAN JOSE
Linden
Farmington
THORNTON
OAKDALE
MODESTO
NEW JERUSALEM
TURLOCK
TURLOCK MUNI
TACAN CASTLE
BONANZA HILLS
NEW MELONES DAM
Copperopolis
Middletown
ANGWIN
76
73
93
22
49
139
23
38
12
45
60

MATHER AFB (MHR) FORECAST GUIDE

1. UNITS SUPPORTED: ATW (T-43, T-37), Attached SAC units (B-52, KC-135). Winds of greater than 25 knots are extremely important because runway orientation is nearly perpendicular to the prevailing wind.

2. PHYSICAL DESCRIPTION AND LOCATION: Mather Air Force Base is located 10 miles east of the City of Sacramento, California in the central valley of California at an altitude of 96 feet above sea level. The only gap in the Coast Range is the exit of the Sacramento River through the Carquinez Strait 75 miles southwest of MHR. The valley slopes slightly to the Bay area. The "Delta" area formed by the meeting of the Sacramento and San Joaquin Rivers lies 50 miles southwest of the base. Although there are numerous lakes and canals in the area, the largest is Folsom Lake 15 miles to the northeast of the base. Vegetation consists mostly of irrigated grain farming to the east with orchards, vineyards and raw crops in other quadrants. There are numerous pollution sources such as burning of rice stubble in early winter, smoke from range fires in summer and fall, smudging when frost occurs at fruit tree blossom time, industrial area to the southwest , etc. The runway at MHR is oriented 04-22.

3. PECULIAR FORECAST PROBLEMS: SEE BAB FORECAST GUIDE.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the BAB Forecast Guide.

5. SEASONAL FORECAST RULES:

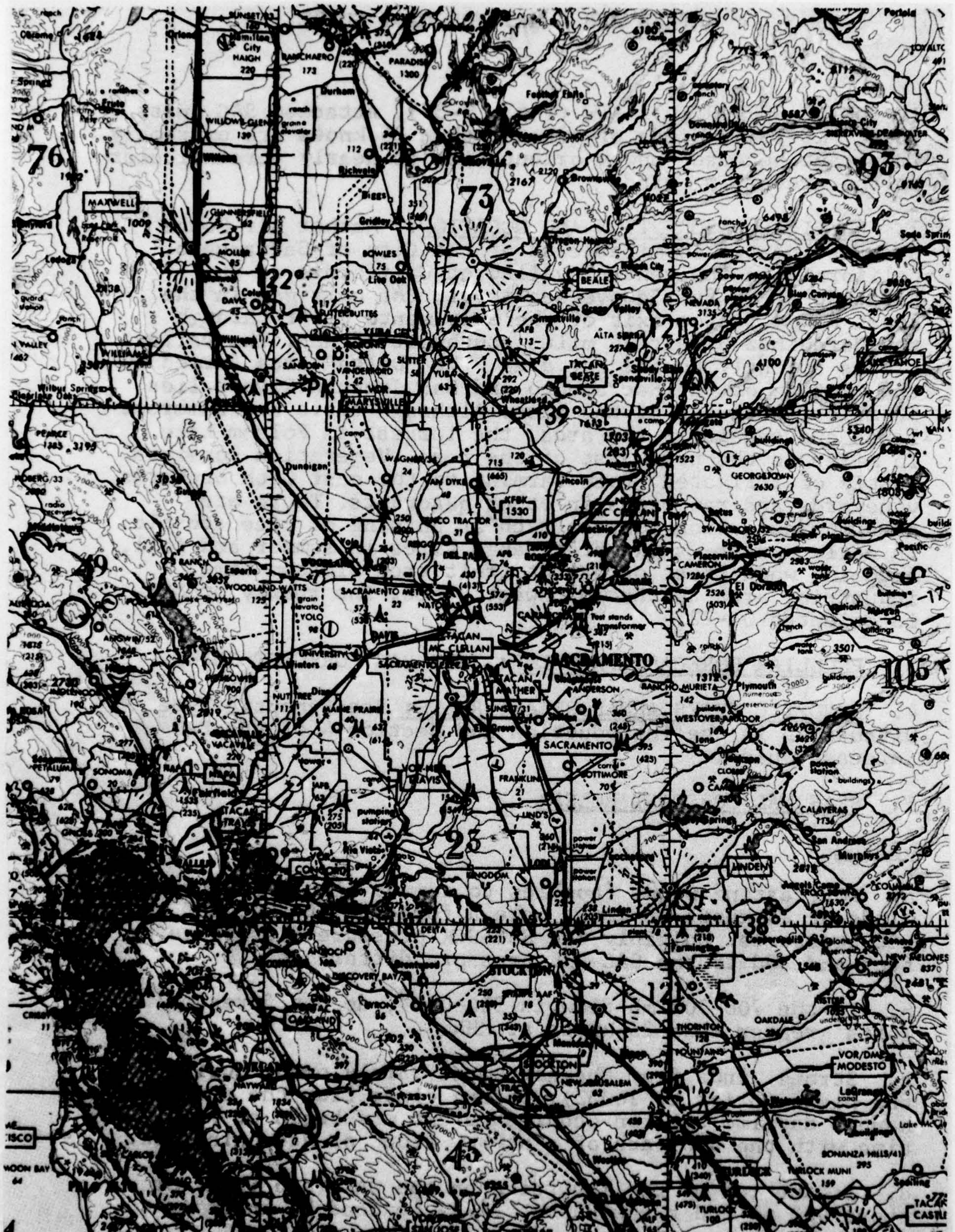
WINTER

a. Forecasting winds (applies to summer also): To forecast winds of 25 knots or more, make a forecast of SCK, SAC and RBL pressures. Multiply the SAC-SCK pressure difference by four and add to the SAC-RBL pressure difference.

b. If the 700-500 mb flow is 360-060°, do not forecast gusts greater than 25 knots at MHR.

c. Strong winds from the northwest rarely occur during the night (prior to 1600Z). Strong winds from the southeast have a daytime bias on occurrence but may begin at any time with the approach of a strong front or deepening low.

d. If the top of the inversion on the OAK raob is at or above 900 mb and the winds at Travis exceed 25 knots in



MAXWELL
BEALE
LAKE TAHOE
McCLELLAN
SACRAMENTO
MATHER
SACRAMENTO METRO
TRAVIS
CONCORD
OAKLAND
STOCKTON
LINDEN
VOR/DME MODESTO
KFBK 1530
GEORGETOWN
CAMERON
EL DORADO
WOODLAND-WATTS
VACAVILLE
SONOMA
FAIRFIELD
DAVIS
FRANKLIN
THORNTON
OAKDALE
MARYSVILLE
YUBA CITY
GRIDLEY
DURHAM
PARADISE
PLYMOUTH
CALAVERAS
SAN ANDREAS
TURLOCK MUNI
BONANZA HILLS
DISCOVERY BAY
ANTIOCH
NEW JERUSALEM
RANCHO MURIETA
WESTOVER-AMADOR

late afternoon, high B or low C stratus is expected in early morning. (SUMMER RULE).

SUMMER

a. If the SUU wind is greater than 25 knots, then MHR wind will also shift in that direction about two hours later.

b. If the upper flow shifts to east through southeast, thunderstorms will drift over the Sacramento area in late afternoon and early evening.

CASTLE AFB (MER) FORECAST GUIDE

1. UNITS SUPPORTED: 93rd Bomb Wg (B-52, KC-135) 84th FIS (F-106, T-33). Additional amendment criteria are 300 feet and/or 1 mile (ADC) and 100 feet and/or ¼ mile (SAC).

2. PHYSICAL DESCRIPTION AND LOCATION: Castle Air Force Base is located six miles northeast of Merced, California at an elevation of 188 feet MSL. It lies in the north central part of the San Joaquin Valley. This valley is bounded by the Diablo and Temblor ranges of the Coast Range (3,000 to 4,000 feet), 40 to 150 miles to the west through south of Castle. The Tehachapi Mountains lie to the south-southeast and the Sierra southeast through northeast. The only breaks in the wall are the Bay-Delta region 100 miles west-northwest of Castle and Pacheco Pass (1,368 feet) 40 miles south-southwest of the base. The San Joaquin Valley has a gradual northwest drainage toward Stockton which gives a shallow upslope to the base from that direction. The major source of air pollution is smudging in the early spring. The worst time is the early morning hours, and visibility restrictions may last a few hours. The runway at Castle is 30-12.

3. PECULIAR FORECAST PROBLEMS: See Section 3 of the BAB Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the BAB Forecast Guide. (Deviations for MER listed below).

a. Type B:

(1) Clouds: None (2) Visibility: 5-7 miles in haze near sunset and sunrise; occasionally B category ground fog. (3) Precipitation: None. (4) Winds: W to NW 10 knots with gusts to 15 in the afternoon.

b. Type C:

Clouds are multi-layered in the vicinity of the front, ceiling C with passage, D category otherwise. In spring, thunderstorms are possible until trough finally passes. Visibility is low D category in rain; intermittently lower in showers. Winds are SE 10-15 ahead of front - veering to S-SW 15-25 higher gusts to 20 knots after frontal passage.

c. Type D:

Clouds are possible D ceilings with approach of front; drop to low D with passage. Rapid clearing behind system with ground fog possible after clearing. Spring thunderstroms


Placerville
El Dorado
Plymouth
Kirkwood
Pacific
Alpine
Wellington
Valley View
Bryant
Bridgeport
Bodie
Darrington
Calaveras
San Andreas
Murphys
Linden
Angels Camp
Long Barn
pumping station
Copperopolis
Farmington
Sonora
New Melones Dam
Tuolumne
Pine Mountain Lake
San Francisco Recreation Camp
Lee Vining
Thornton
Oakdale
Fountains
VOR/DME
Modesto
LaGrange
Lake McClure
Bonanza Hills
Turlock Muni
Turlock
Snelling
Mariposa-Yosemite
TACAN
Castle
Atwater
Merced
Le Grand
Erlant
Coarsegold
North Fork
Oakhurst
Gustine
New Hall
Los Banos
Chowchilla
Triangle T
Madera
Eagle
Firebaugh
El Peco
Yosemite Hidden Lake
Fresno Air Terminal
Fresno
Chandler
Sierra
Gandy
Sanger
Squaw Valley
Wonder Valley
Orange Cove
Badger
Alta
Quinn
Coarsegold
Abandoned
Aquarius
building
buildings
power plant
power station
camp
ranch
ski tow
numerous mines
fair grounds
38°
37°
121°
120°
119°
17°E
16°E
105
126
133
60
83

may occur with this type. Low D category visibility in showers. Winds are S 10 increasing gusts to 25-35 as front approaches; NW gusts 20-30 knots after passage.

e. Type E, Winter:

EPHEMERAL STRATUS

(1) Clouds: Radiation fog at night lifts to B ceiling with heating and generally becomes scattered at maximum temperature times. Duration of fog and stratus increase each successive day this regime persists eventually becoming "persistent" stratus.

(2) Visibility: A category morning to C or D category afternoon.

(3) Precipitation: Possible early morning drizzle.

(4) Winds: SE 0-5 morning; NW 6-10 afternoon.

PERSISTENT STRATUS

(1) Clouds: A or B category at night; B category during day. Does not clear out until frontal passage occurs.

(2) Visibility: A category at night, B or C during day.

(3) Precipitation: Possible early morning drizzle.

(4) Winds: L/V - southeast during daylight hours.

f. Type E, Summer:

(1) Clouds: None. (2) Visibility: Unrestricted

(3) Precipitation: None. (4) Winds: L/V, SE during day.

g. Type E_1, summer: Same as above except winds are NW 10 gusts 15-25 afternoons with further increase if Pacific High pushes eastward.

5. SEASONAL FORECAST RULES:

WINTER

a. Using the 00Z data: A temp-dewpoint spread greater or equal to 16°F signifies that visibility will not be less than ½ mile in the following 24 hours.

b. A dewpoint temperature less than 32°F will generally signify that visibility will not be less than ½ mile in the following 24 hours.

c. An altimeter less than 29.95 inches indicates that visibility will not be less than ½ mile.

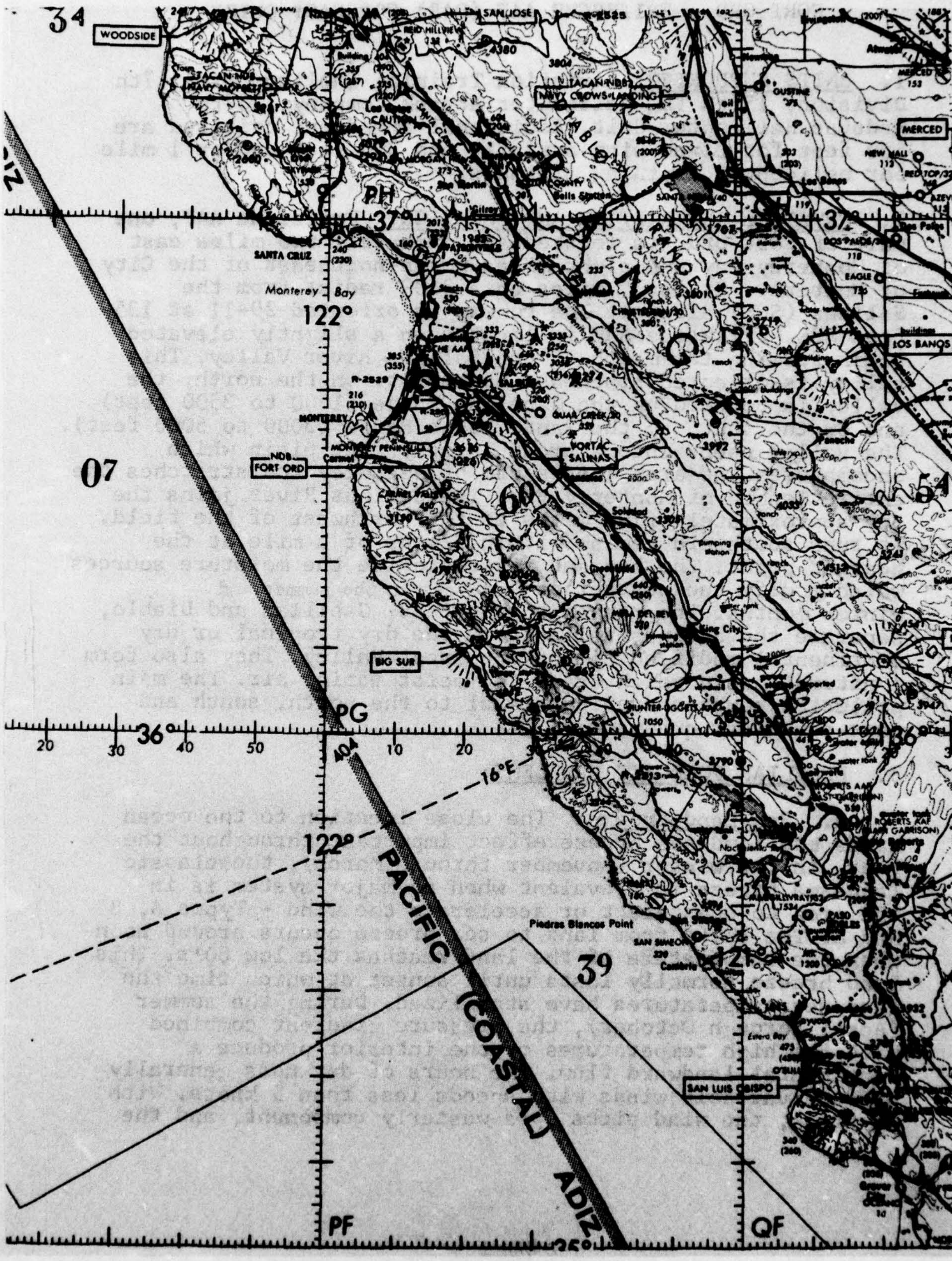
FORT ORD - FRITZSCHE AAF (OAR) FORECAST GUIDE

1. UNITS SUPPORTED: Aviation Training (helicopters), 7th Division, 155th TAC Helicopter Attack Company, 237th Medevac Helicopter Unit. Additional amendment criteria are 500 feet for fixed wing arrivals and 300 feet and/or 1 mile for helicopter training minimums.

2. PHYSICAL DESCRIPTION AND LOCATION: Fritzsche AAF, one part of Fort Ord, is located approximately two miles east of Monterey Bay and eight miles north-northeast of the City of Monterey. It is 7½ miles on a 260° radial from the Salinas (SNS) airport. The runway is oriented 29-11 at 135 feet MSL. Fritzsche AAF is located on a slightly elevated plain forming the mouth of the Salinas River Valley. This valley is oriented southeast-northwest. On the north, the valley is bounded by the Gabilian Range (1500 to 3500 feet) and on the south by the Santa Lucia Range (3000 to 5000 feet). The valley opens into a broad largely flat plain which encompasses the area just south of Monterey and stretches the entire length of Monterey Bay. The Salinas River joins the Bay approximately five miles to the northwest of the field. It runs southward coming within 3/4ths of a mile at the nearest point. The bay and river provide the moisture sources which modify the weather at Fritzsche in the summer and winter months. The ranges to the east, Gabilian and Diablo, separate the Salinas Valley from the dry tropical or dry continental modified air of the Great Valley. They also form a natural basin which traps the moist marine air. The main pollution sources are industrial to the north, south and east-southeast quadrants.

3. PECULIAR FORECAST PROBLEMS:

a. Sea-Land Breeze: The close location to the ocean makes the land-sea breeze effect important throughout the year. In the winter (November through March), the classic land-sea breeze is prevalent when no major system is in the area to counteract or accelerate the wind - Types A, B and E. The shift from land to sea breeze occurs around noon when the temperature of the land reaches the low 60's. This land breeze normally lasts until sunset at which time the land-sea temperatures have stabilized. During the summer (April through October), the pressure gradient combined with the high temperatures of the interior produce a continental landward flow. The hours of darkness generally produce variable winds with speeds less than 5 knots. With daybreak, the wind picks up a westerly component, and the


34
WOODSIDE
SAN JOSE
NAVY MOFFETT
NAVY CROWS LANDING
MERCED
LOS BANOS
SANTA CRUZ
Monterey Bay
PH
37°
122°
MONTEREY
NDB
FORT ORD
VORTAC
SALINAS
07
60
54
BIG SUR
PG
36°
16°E
122°
PACIFIC (COASTAL) ADIZ
Piedras Blancos Point
SAN SIMEON
39
SAN LUIS OBISPO
PF
QF

speed steadily increases until it reaches 15-20 knots around noon. This strong westerly wind lasts until a few hours after sunset. Also associated with this onshore flow is the cold water current which lies just of the coast and causes an upwelling of marine air which produces stratus and pushes it onshore in the late afternoon. It lasts through the night and into late morning or early afternoon. The thickness of the marine layer determines the breakup time.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the BAB Forecast Guide. The rules for BAB and MER in Section 4 apply to OAR as well with the following exceptions.

a. Type A: If a front does manage to struggle southward to Fort Ord, periods of low stratus are likely before passage and 4-6 hours after.

b. Type A_1: About the same as at BAB except that intensity of rainfall will be somewhat heavier and therefore the accompanying ceilings probably somewhat lower. After frontal passage, the ceilings are about the same. Post-frontal stratus and fog is not likely with this type.

c. Type B: No weather of consequence in winter and may signal the end of a deep stratus/fog regime at OAR in the summer months.

d. Type B_1: Same weather as interior stations except rain will, of course, start sooner and may last a little longer after front passes. Again, the basic difference is the unlikelihood of any radiation fog or advected stratus once the upper trough has passed.

e. Type B_2: Same as Type B_1 for OAR.

f. Type C: No weather of consequence.

g. Type C_1: Same weather as interior stations. Instability showers may persist for slightly longer after frontal passage.

h. Type C_2: Ft. Ord Monsoon - by far the heaviest rain regime of all. Once the original front passes, the rain may not stop until the low off the coast either drops South or crosses the California coast.

i. Types D, D_1, D_a: No weather at OAR unless jet is west of station, then broken middle cloudiness is possible. No

gusty winds from the NE occur as with inland stations.

j. Types E, E_1: May produce a stratus/fog regime sporadically in winter. In summer, it will produce one and for several days at that.

5. SEASONAL FORECAST RULES:

WINTER None.

SUMMER

a. If the low-level wind flow from the surface to 2,000-3,000 feet has a land trajectory, (010-150°), no stratus is likely until the sea breeze takes over giving the air a water trajectory.

b. If OAR is clear in the morning, 0600-0700L, but SNS and MRY have fog and stratus, these conditions will usually be advected over the field giving B category ceilings within an hour or so.

c. Whenever a strong trough aloft over California exists or develops, prevailing stratus conditions will break up due to less stable air breaking down the surface inversion.

d. When a northwest flow aloft exists, stratus will come in later during the evening as opposed to a southwest flow aloft which will bring the stratus in earlier.

e. Stratus ceilings are most likely to occur if the 1000 mb height at OAK at 1200Z is less than 130 meters.

f. Occurrence of stratus is precluded if the temperature of the base of the primary inversion is greater than 60°F on the Oakland sounding.

g. A ceiling of 700-900 feet (B category) will lift to 1,000 feet (C category) within two or three hours after the 0700L observation.

REGION 3

NORTHERN PLAINS FORECAST GUIDES

Malmstrom AFB . . . . GFA
Minot AFB . . . . MIB
Grand Forks AFB . . . . RDR
Ellsworth AFB . . . . RCA

MALMSTROM AFB (GFA) FORECAST GUIDE

1. UNITS SUPPORTED: 17th DSED (B-57), Det 5, ARRS (MAC), T-33 (Norad), Det 1, 916th ARS (KC-135). 341st SMW.

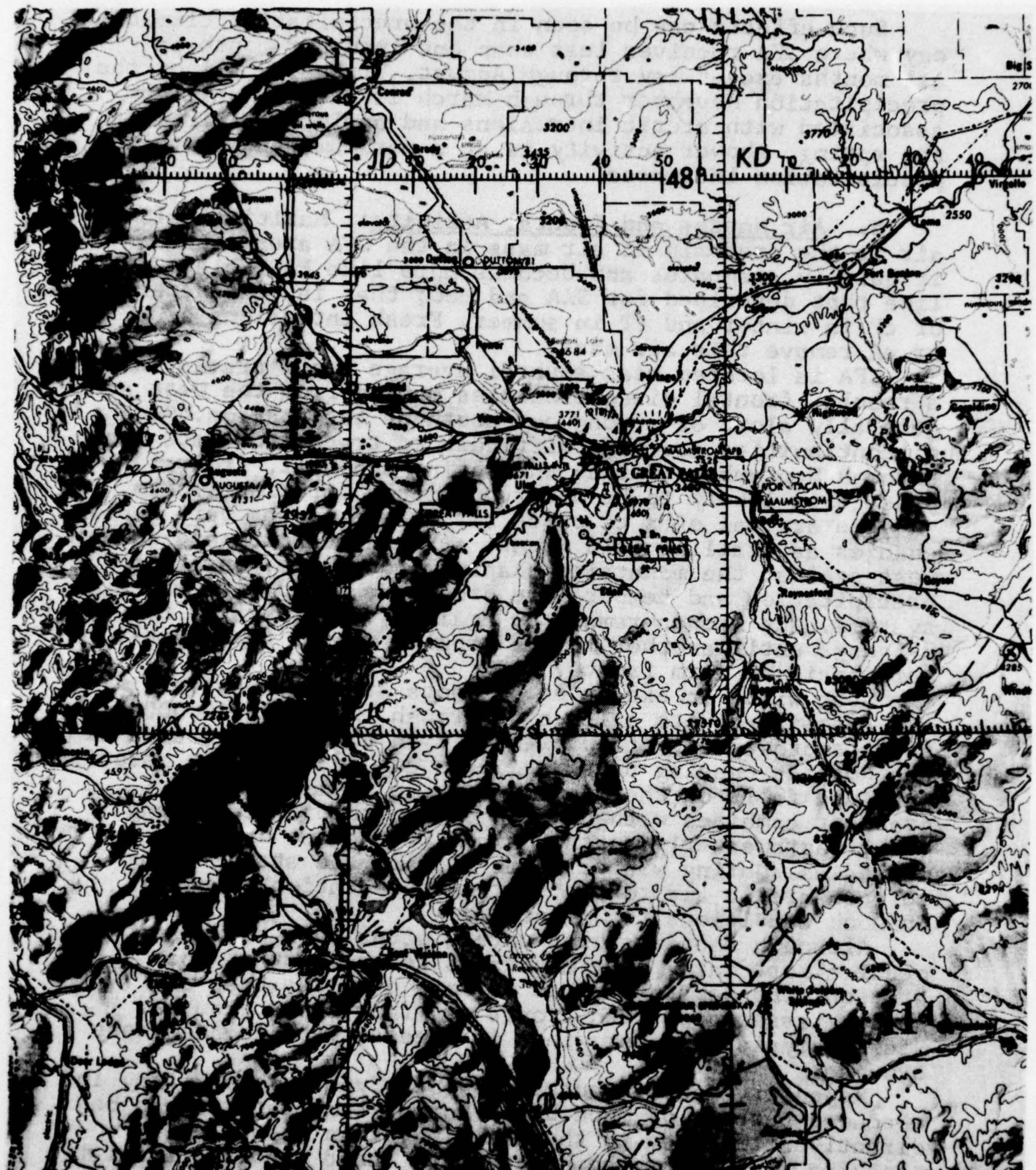
2. PHYSICAL DESCRIPTION AND LOCATION: Malmstrom AFB lies at an elevation of 3523 feet (2 miles east of Great Falls) on the southern extremity of a broad basin defined on all sides except north by mountains. The base itself is about 80 miles from the Continental Divide which lies to the southwest. Helena lies 60 miles south-southwest of the base in a valley containing a large reservoir which essentially forms the headwaters of the Missouri River. The river flows towards Great Falls and emerges from a canyon 25 miles to the southwest of the city. From there it meanders through Great Falls and passes two miles north of the base. Topography exerts very strong influences on the weather at GFA and will be addressed in the next section. There are only two minor pollution sources west-southwest through northwest in the city of Great Falls. The runway is 20-02.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The location of GFA with respect to the Rockies affects all aspects of its weather. The basin that the base lies in is characterized by rolling hills in the local area within 15 miles of the base. Further out, the mountains lie in all quadrants except north-northeast. The Bearpaw Mountains (6,000 feet) lie 90 miles northeast of the base; the litte Belt Mountains 20-40 miles to the east through southeast averaging about 6,000 feet with several higher peaks; the Big Belt Mountains 45 miles southeast through southwest (6-8,000 feet). The Lewis Range (Continental Divide - main Rockies) lies 80 miles southwest through northwest.

The upslope-downslope configuration is complicated somewhat by the fact that the mountains nearly surrounding the basin are not equidistant from the base (reminiscent of the Fairchild AFB area). Winds blowing from south-southeast through north-northwest are essentially downslope in character with the strongest effect noted in west or west-southwest winds. Winds from north through east are upslope within fifty miles of the base . Easterly gradient winds will deflect toward the north as a result of the mountains just to the east-southeast of the base.

Maritime air masses from the west are first lifted over the Cascades and then again over the Rockies leaving little moisture available by the time they reach the base. This is the primary explanation for not attempting to forecast low middle cloudiness in advance of a mP front at GFA. On the other hand, relatively little moisture moving over the upslope from the north through northeast can produce abominable flying weather.


JD
KD
48
Conrad
Virgelle
Fort Benton
MALMSTROM
GREAT FALLS

Such effects can be seen in the precipitation climatology where GFA receives less than one inch per month in all months except May through August. Virtually all of the precipitation November through March is snow primarily associated with arctic intrusions and upslope lifting. In the spring, shower activity is at a maximum, and monthly precipitation increases.

b. Air Masses and Frontal Activity: Maritime polar air is the predominant air mass in the GFA area although it quickly stagnates and becomes more like PB (Polar Basin) like that described for SKA and MUO; that is, characteristics of cP in winter and cT in summer. Fresh intrusions of cP or cA remove this air mass.

GFA is located near several average storm tracks. As a result, frontal discontinuities moving from the west are generally aloft or strung out south of the station. Such discontinuities are very difficult to trace from late June through September. During the spring and fall, frontal passage is likely to be observed with a maritime system.

The arrival of a cP or cA air mass produces very rapid changes as trailing cold fronts are pushed south and southwest against the mountains. Rapid wind shifts, onset of precipitation and temperature drops are noted with these systems. The fronts remain up against the mountains for 3-5 days until another moving impulse starts them eastward again as warm fronts.

Most winds in excess of 30 knots are southwesterly and associated with a lee-side trough. Deep (to 10,000 feet) southwesterly flow piles air on the windward side of the Rockies causing pressure rises; and coupled with associated pressure falls on the leeward side, a strong pressure gradient combines with downslope flow to produce strong gusty southwesterly surface winds in the lee of the mountains. During winter, this flow may be strong enough to push arctic air to the east of the station bringing Chinook conditions to Malmstrom.

Although thunderstorms rarely occur over the base, they occur almost daily over mountains to the west of the station. Thunderstorms that do move over the base are usually associated with fronts or minor upper troughs. Microanalysis of upper winds is necessary to locate these troughs.

Repeditive arctic outbreaks (See Type E_8) resulting in extended periods of much below normal temperatures can be directly attributed to the building of an upper-level blocking ridge near the West Coast. These conditions exist as long as the cold Aleutian Low is displaced 500-800 miles west of its normal position, a quasi-stationary cold low exists over Hudson Bay and the blocking ridge extends over Alaska.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

WINTER

a. Type A: The type has to be advanced enough for a good Alberta Low to form. Major trough is off the West Coast. The surface front will pass from the west or northwest. The occluded front may be aloft. Southwesterly flow aloft in depth.

(1) Clouds: Broken to overcast low E category clouds decreasing with passage and clearing after minor trough passage usually within 3-4 hours.

(2) Visibility: Unrestricted.

(3) Precipitation: Likely in mountains - rare at GFA.

(4) Winds: SW 15-20 ahead of front; NW 10-15 after front for 3 hours.

b. Type B: Zonal type pattern with strong moving troughs embedded. mP frontal passage possibly followed in six hours by arctic outbreak depending on strength or existence of cA high in Canada. Flow aloft is southwest through west with mean trough off Pacific coast.

(1) Clouds: E category middle cloudiness with short period of D at frontal passage; may be C if precipitation is forecast at the station. With arctic front, expect B or low C for 6-8 hours.

(2) Visibility: Unlimited decreasing to C in vicinity of front if precipitation expected and to B with passage of arctic front.

(3) Precipitation: Intermittent snow with mP front and light to moderate snow right at passage of arctic front.

(4) Winds: SW 15-25 shifting to NW 15-20, then to N 20-30 knots with arctic front becoming variable 5-6 hours later.

c. Type C: Systems moving along the Canadian Border associated with the northern part of the Type C trough pattern usually track from northern British Columbia to Glascow (GGW) and on eastward to the Great Lakes. In split flow, they may be totally separated from the (California) low in the base of the main upper trough. This system is usually followed by a weak arctic outbreak but can be much stronger (like an E type) if strong upper air ridging exists into the Yukon. Upper air flow is southwest ahead of the system shifting to northwest or north behind trough.

(1) Clouds: Low E category ceilings becoming D for a short while between front and trough following it. Upslope B category stratus may develop 3 hours later and remain until the moisture moves out of the area. (Consider if Lake Winnepeg is frozen or not).

(2) Visibility: C category in light snow, D category in rain early and late in the season. B category likely under upslope stratus.

(3) Precipitation: Light precipitation unless wave forms to the southwest and moves up mP front.

(4) Winds: SW 15-20 knots ahead of front. N 25-30 with higher gusts for several hours after frontal passage then becoming variable.

d. Type D: This type presents no problem unless the Colorado Low recurves into western South Dakota (highly unlikely).

e. Type E: Strong ridging over western Canada, cold air exists on the surface to 850 mb so fronts ride over it aloft. Westerly or northwesterly flow aloft with well-marked minor troughs in the height field.

(1) Clouds: Broken to overcast middle (low E category) 12-18 hours ahead of front. Low D or high C category clouds between front and trough aloft. Gradual clearing will occur after trough passage.

(2) Visibility: Unlimited. Down to D then B or C category in snow for a short period with front aloft.

(3) Precipitation: Light snow up to 6 hours in advance of the front.

(4) Winds: Variable less than 10; NE-N 10-15 knots after upper front; NW 10 after trough passage.

f. Type E_S: Very strong ridging aloft with northerly or northwesterly flow. (Can also happen with some Type C patterns). Arctic outbreaks can be expected. Low moving into Hudson Bay drags arctic high southward along the east slopes of the Rockies becoming stationary up against the Rockies to the west. Waves may move southeastward along the front.

(1) Clouds: Overcast clouds to 15,000 feet with and after arctic front. Although middle cloud clears out 2-4 hours afterward, low clouds (B category) are likely to persist 12 hours. Waves moving along front will cause the ceiling to stay down.

(2) Visibility: A or B category in snow and blowing snow. May persist with waves and even into first cloud free morning.

(3) Precipitation: Moderate snow with front for 6 hours followed by persistent light snow which will continue with waves.

(4) Winds: SW 10-15 shifting to N 20-30 with higher gusts for 6 hours, then becoming variable. Same sequence with waves - winds less than 15 knots.

SUMMER

a. Summer patterns are mostly B or weak E types, that is modified mP air replaced at regular intervals by fresh mP and an occasional continental system. Very little significant weather occurs as most thunderstorms remain over the mountains. A, C and D patterns are quite rare in the summer. The best rule at GFA is to avoid forecasting anything below 10,000 feet and 6 miles unless there is a strong surface synoptic feature with good upper air support.

b. Type Y described for RCA, MIB and RDR does not affect GFA as a rule.

5. SEASONAL FORECAST RULES:

WINTER

ARCTIC FRONTS

a. Expect passage at GFA 9 hours after passage at Lethbridge.

b. Expect passage at GFA 9:25 hours after FROPA at Calgary.

c. Forecast arctic frontal passage within 24 hours whenever YZU-GTF pressure difference equals or exceeds 6 mb.

UPSLOPE

a. Upslope conditions begin 1:30 hours following arctic frontal passage.

b. Surface winds from west-northwest through north over 25-35 knots with arctic frontal passage.

FOG

a. Ice fog can be expected with temperatures below $10^{\circ}F$. (Vehicular and aircraft activity increases the probability and As the temperature falls below $-10^{\circ}F$, the probability decreases.

SUMMER (April through September)

a. Use 100% of the thunderstorm height for peak gusts expected. For 35,000 foot tops, forecast 35 knots peak.

b. Forecast thunderstorms over the Rocky Mountains whenever the Showalter stability is +4 or less and the flow aloft is southwesterly.

ALL SEASONS

a. Ceilings of 300-1000 feet can be expected with flow 330-110° (clockwise) when (1) a low cell is moving eastward through southern Montana or Wyoming. The low cell usually forms west of mountains and moves in association with a weak mP front which is moving more rapidly in Canada than in the U.S.,(2) there is easterly flow with ceilings occurring first at Lewistown (LWT) and lowering over GFA. and (3) there is moist air presented. Winds in the lower few thousand feet are NE at 5 or more for 6 or more hours.

b. Upslope conditions will break when Helena's sea level pressure is equal to or greater than Cutbank's.

c. Northwesterly flow of 35-40 knots at 10,000 feet will produce occasional moderate turbulence. An exception is an inversion between the surface and 10,000 feet.

d. When GFA is dominated by a lee-side trough, determine peak gusts by using 100% of the westerly flow over Spokane at 700 mb.

e. Forecast 35 knots whenever lee-side trough is present and the ALSTG at HLN is greater than equal to GTF by .13 inches, and winds aloft are southwest through west greater or equal to 30 knots.

f. If a Pacific frontal passage is forecast from west, expect gusty surface winds from southwest through northwest at 80% of wind vector from 8,000 to 12,000 feet over Spokane.

g. Visibility does not normally equal or go below ½ mile with fog.

h. Do not forecast continuous precipitation at GFA when the HLN ALSTG is greater or equal to GFA.

ADDITIONAL RULES:

WINTER

a. When a 500 mb ridge to the west moves within 500 miles of GFA and an arctic front has been moving toward GFA, forecast the front to remain east of the station unless the ridge begins to retrograde.

b. Heavy snowfall can be expected when deep (near 8,000 feet MSL) arctic air is over GFA with a warm-moist Pacific front aloft. If a low cell forms at the point of intersection (where front goes aloft over the arctic air) larger amounts of snow can be expected.

SUMMER

a. Visibility rarely goes below three miles with thunderstorms.

b. Thunderstorms normally produce ceilings of 5-6,000 feet.

c. Hail is usually small with thunderstorms.

ALL SEASONS

a. A north-south oriented trough is accompanied by little weather, except when associated with a cold trough or low aloft. In that case, expect showers.

b. Northeast-southwest orientation will normally be followed by upslope conditions.

c. When Whitehorse's (XY) sea level pressure becomes greater than GFA's, expect upslope conditions to result approximately 22 hours later.

MINOT AFB (MIB) FORECAST GUIDE

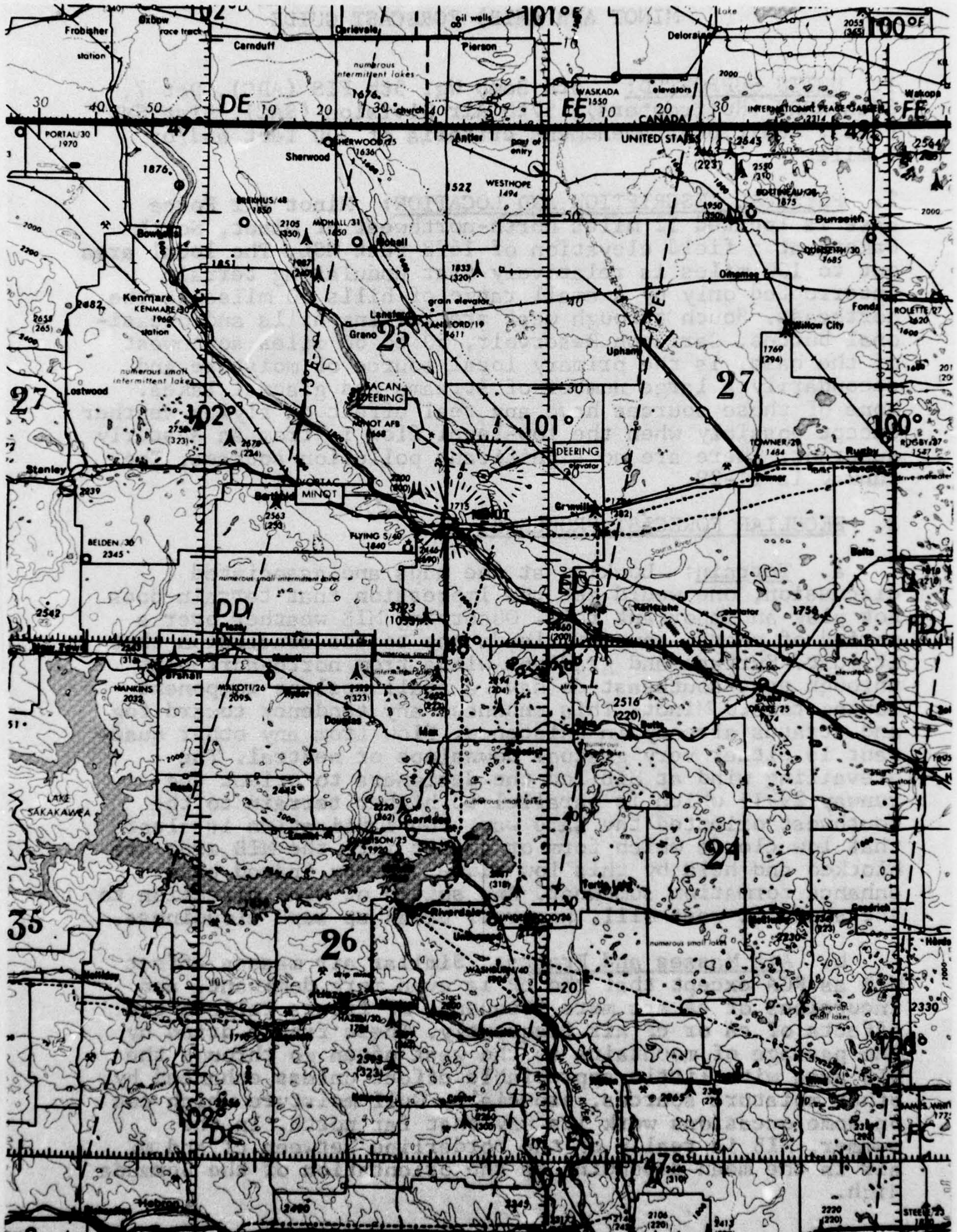
1. UNITS SUPPORTED: 5th Bomb Wg, 5th FIS (ADC), Det 7, 37th ARRS (Helicopters), 57th Air Division (SAC), 91st SMW (SAC). Additional amendment criteria of 300 feet and/or 1 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Minot Air Force Base is located 12 miles north-northwest of Minot, North Dakota at a field elevation of 1678 feet MSL. The local area out to 100 miles is relatively flat undulating terrain interrupted only by a small range of hills 50 miles to the northeast. South through west are rolling hills and occasional buttes. Garrison Reservoir, 50 to 60 miles southwest of the base, is the primary local source of moisture and secondarily a large number of streams and glacial lakes. None of these sources have any real effect on flying weather except possibly when the low-level flow is from an easterly quadrant. There are no significant pollution sources. The runway is 11-29.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Looking at the maps and associated discussion, one would get the impression that terrain does not play an important role. Observing MIB weather over a period of years, however, leads one to the conclusion that it must. Surface and gradient winds from north-northeast through east-southeast do have a small upslope component moving toward Minot. This enhances any tendency toward fog and stratus already in existence. Flow from any other quadrant is either very gradual downslope or neutral. The prevailing wind at MIB led the designers to orient the runway 29-11 which is parallel to higher terrain to the southwest oriented the same way. The implication is clear that low clouds which form or advect into the MIB area are blocked and held by this low ridge. It may indeed even enhance formation somewhat. Any switch of wind direction to the south or west will, however, break up such cloudiness.

b. Air Masses and Fronts: Similar air masses affect MIB as RCA except that the cP is even more dominant, and incursions of cA are more frequent. mP fronts relieve the effects of cA or cP air frequently. These fronts dried by the passage of mountains to the west often go through the MIB area with little appreciable effect unless enhanced by other moisture sources, especially Gulf moisture which can on some occasions work its way that far north. In the summer, MIB is really on the borderline between cT and mT air in the mean depending on the orientation of the Bermuda High.



Frobisher
Oxbow
Carnduff
Carievale
Pierson
Deloraine
101°
100°
102°
DE
EE
FE
DD
ED
FD
DC
EC
FC
numerous intermittent lakes
WASKADA 1550
elevators
CANADA
UNITED STATES
INTERNATIONAL PEACE GARDEN
PORTAL/30 1970
Sherwood
SHERWOOD/25 1636
Antler
port of entry
WESTHOPE 1496
Bowbells
Mohall
MOHALL/31 1650
Dunseith
DUNSEITH/30 1685
Kenmare
KENMARE/30 1960
Lansford
LANSFORD/19 1611
Grano
grain elevator
Upham
Willow City
Fonda
ROLETTE/27 1620
numerous small intermittent lakes
Lostwood
TACAN
DEERING
MINOT AFB 1668
Stanley
VORTAC
MINOT
Berthold
TOWNER/29 1484
Towner
Rugby
RUGBY/27 1547
FLYING S/40 1840
BELDEN/30 2345
Minot
Granville
Souris River
Velva
Karlsruhe
elevator
numerous small intermittent lakes
HANKINS 2032
MAKOTI/26 2095
Douglas
Max
Butte
LAKE SAKAKAWEA
Garrison
GARRISON/23 1920
Riverdale
Underwood
WASHBURN/40
McClusky
Goodrich
numerous small lakes
Turtle Lake
Hazen
HAZEN/30
Missouri River
Hebron
25
26
27
24
35
47
48

While most fogs in the MIB area can be classified as almost pure radiation type fog, a number of cases of upslope and frontal type fogs are observed. Once fog is observed, it will tend to reform each night that the air mass remains stagnant over the area. Calm or light winds with a south to southeasterly component are most favorable for fog formation. The upslope effect compounded by surface radiation is reflected at Minot in that prolonged southeast winds will bring stratus ceilings or fog to Minot five hours after Jamestown, North Dakota is affected. The earlier in the pre-dawn morning the fog forms, the longer it will persist after sunrise. With the exception of some upslope fogs, fog usually dissipates within 2-4 hours after sunrise.

Recurring arctic outbreaks (See Types C, E, E_s) bringing prolonged periods of below normal temperatures are associated with the building of an upper-level blocking ridge near the West Coast. These conditions will persist as long as the cold Aleutian Low is displaced 500-800 miles west of its normal position, a quasi-stationary cold low exists over Hudson Bay and the blocking ridge extends over Alaska.

The ridge over Canada and the northern U.S. is sharply defined with its contours closely paralleling the Canadian Rockies. Abnormally warm surface temperatures over southern and central Alaska result from constant warm advection into the ridge from the displaced Aleutian Low. Because of blocking by the ridge, arctic outbreaks originating over Siberia travel across the Bering Sea, pass north of Fairbanks, and move southward into Canada 200-400 miles to the east of Fairbanks. The combination of the flow around the Hudson Bay low, and flow on the east side of the ridge produces a continuous flow of cold air which pushes southward along the east slopes of the Rockies. Normally, a stationary front is held tightly against the eastern slopes of the Rockies by repeated arctic outbreaks.

4. SYNOPTIC TYPES AND FORECAST RULES:

WINTER

a. **Type A**: (Watch for cold front returning off Rockies as Warm front).

(1) **Clouds**: Broken to overcast middle cloud in low E or high D category 6-8 hours ahead of front reaching C category in frontal zone for a couple of hours. If a cP or cA front is flowing, expect intermittent B category about 800 feet for several hours after the front passes. If the front becomes stationary just south of the MIB, or upslope is anticipated, hold the cloud in longer. Normal clearing is 10 hours after the continental boundary passes.

(2) **Visibility**: Unlimited except 1-2 miles in snow and blowing snow for several hours after frontal passage. Longer periods can be expected if the wave is close to the station.

(3) Precipitation: Light snow in frontal zone persisting until after continental boundary passes. May be moderate if Alberta Low passes close to or south of station (which is likely).

(4) Winds: SSE 15-25 knots shifting to 25-35 knots with higher gusts after passage for up to 12 hours. Will shift to a west flow when the cold air moves away from the Rockies.

b. Type B: Low centers in zonal flow aloft move north of Canadian Border but may pass close to Minot. As a result, continental fronts are more likely with these systems than at RCA. Although they may be weak, more precipitation is likely with lower cloud conditions for longer periods than either RCA or GFA.

(1) Clouds: Broken to overcast middle clouds in E category ahead of front by 6-12 hours - may become D prior to frontal zone if wave is near station. Low D category in frontal zone falling to intermittent C or B for a few hours after mP frontal passage. Appearance of a cP front will prolong the B or C category ceilings.

(2) Visibility: Unlimited except C or B category in snow and blowing snow in vicinity of mP front until several hours after continental front (if present) passes.

(3) Precipitation: 2-4 inches of snow.

(4) Winds: SSE 15-20 shifting to NW gusts 25-40 knots after passage for 6-12 hours depending on speed of wave.

c. Type C: Waves forming on continental boundary near arctic front form in British Columbia and move southeastward close to Minot. This occurs regardless if main low is coming out of the southwest U.S. or not, and surface lows are not associated with surface lows coming out of the southern Rockies. Upper air mini-troughs are sharp and follow surface waves into the Great Lakes.

(1) Clouds: Broken to overcast B category as wave passes to south of station. Clouds will break for a while if wave goes north of station. Ceilings will generally rise behind system to C category and remain for 24-48 hours.

(2) Visibility: A or B category in snow and blowing snow will persist for 12 hours after wave passes station.

(3) Precipitation: Moderate to heavy snow ahead of wave turning to snow showers behind it.

(4) Winds: Increasing and backing to NW 25-30 knots for 12 hours. Winds taper off and turn to NE.

d. Type D: As has been implied, the track of Type D storms is critical to each station in the Northern Plains. If the surface system passes through central Nebraska into western Minnesota or eastern North Dakota, then MIB is in

trouble with somewhat less weather at RCA and rain at OFF. For the low to take this track, upper air flow must recurve very sharply and normally only occurs when a new system is moving into the Pacific Northwest with strong warm air advection over the Mississippi Valley.

(1) Clouds: D category stratocumulus and overcast middle cloudiness deteriorating rapidly to B as snow begins or even A. Ceilings do not improve until the low reaches INL. Then expect C category for a couple of days, especially if a large upper air center becomes closed over the northern Great Lakes maintaining the surface low.

(2) Visibility: B or A category improving to C as snow tapers off and winds become northerly.

(3) Precipitation: Heavy snow up to a foot. Huge drifts. Snow showers will continue until low is through Lakes.

(4) Winds: SE-NE 35-45 knots and may reach 60 knots. Backing to NW occurs, and winds slowly decrease as low continues into Lakes.

e. Type E or E_s: Old occlusions ride up over arctic air in British Columbia and form waves south of the continental boundary. As these waves move southeast, arctic outbreaks are forced southward east of the Rockies with a high center often going right over MIB. Highs are apt to continue to reinforce the cold air as long as intense ridging remains over western Canada. Type E_s outbreaks are even more severe, and distinguishing between the two by observed weather is not necessary. E_s is also more likely to be constantly reinforced.

(1) Clouds: Band of low ceilings in C category 100-200 miles wide behind cold front. The possibility exists that the cold air will return off the Rockies ahead of the next reinforcing wave. If that happens, forecast another period of high C or low D depending on persistence.

(2) Visibility: D category in light snow.

(3) Precipitation: Light snow showers.

(4) Winds: Rapid shift to NW from either WSW (if cold air east of MIB) or SSE (if front stationary along Rockies) 10-25 knots, possible blizzard (from snow already on ground) with greater than 1040 mb high. Winds persist behind front up to 8 hours, then variable. Shift first to SE, then to W if front comes back off Rockies (not likely if E_s).

SUMMER

Type E and B are the most common with generally weak patterns and gradients. The B has an interesting variation.

a. Type B: An initial Type B front moving from the west may get stalled as it meets a surge of mT air flow from the

Plains - passing MIB and RDR but no stations to the south. Waves may form on the trailing front in Wyoming and move out. These can present serious severe weather problems to many stations in the Northern Plains.

(1) Clouds: E category middle cloudiness with initial front. Intermittent C category as waves form on the trailing front and move south of the station. Bases of squall-lines are usually in D category.

(2) Visibility: Unlimited until waves form. C category is generally the lowest unless drizzle forecast, then B.

(3) Precipitation: Showers and thundershowers. Possible drizzle with front to the south.

(4) Winds: S-SW 10-15 ahead of initial front shifting to W 15-20 with higher gusts for up to 4 hours. Winds backing and increasing again at intervals as waves pass.

b. Type Y: Weak ridging in central Canada with near zonal but weak flow over MIB. High over Great Basin is stronger than normal. cP high over Manitoba or Great Lakes drifting SSE or stationary. Upslope conditions exist and are apt to last several days.

(1) Clouds: Overcast stratus forming around 0600Z and remaining through mid-morning. Usually is in B category possibly A. Watch for middle clouds as this will increase the length of time needed to break up the clouds.

(2) Visibility: B or C category depending upon precipitation. 5-7 miles in afternoon. A category is possible if winds are very light near sunrise.

(3) Precipitation: Trace drizzle or late and early season snow flurries.

5. SEASONAL FORECAST RULES: All Seasons.

a. Southeast winds over 34 knots are very rare except with a thunderstorm.

b. In the fall through spring, with any great amount of cold air advection from any direction, it will produce ceilings less than 3,000 feet and most probably between 1,500-2,000 feet.

c. Surface winds from 010-150 degrees are upslope winds for Minot. If other weather conditions such as moisture are present, always consider the possibility of forecasting a stratus deck or fog.

d. Thunderstorms passing over the station from 220-300° have the greatest probability of producing surface wind gusts of greater than 35 knots than thunderstorms moving in from any other direction.

GRAND FORKS AFB (RDR) FORECAST GUIDE

1. UNITS SUPPORTED: 319th Bomb Wg, 179th Aviation Det (CA-47, UH-1), Det 3, ARRS (UH-1), ANG Minneapolis (C-130).

2. PHYSICAL DESCRIPTION AND LOCATION: Grand Forks Air Force Base is located 15 miles west of the North Dakota-Minnesota Border at a field elevation of 911 feet MSL. The base lies on the western side of the Red River Valley, 65 miles south of the Canadian Border. Like other Northern Plains stations, the effects of topography are very important and account for an important percentage of RDR marginal flying weather. Even though MIB and RDR are not physically separated by many miles, their weather is all together different, especially in the winter. This fact must be kept in mind. Industrial pollution is nil as the base is totally surrounded by flat farmland. Unfortunately, the local on-base sources, although not sufficient to produce day-to-day visibility problems, can trigger the formation of fog when atmospheric conditions are favorable. The runway is oriented 17-35.

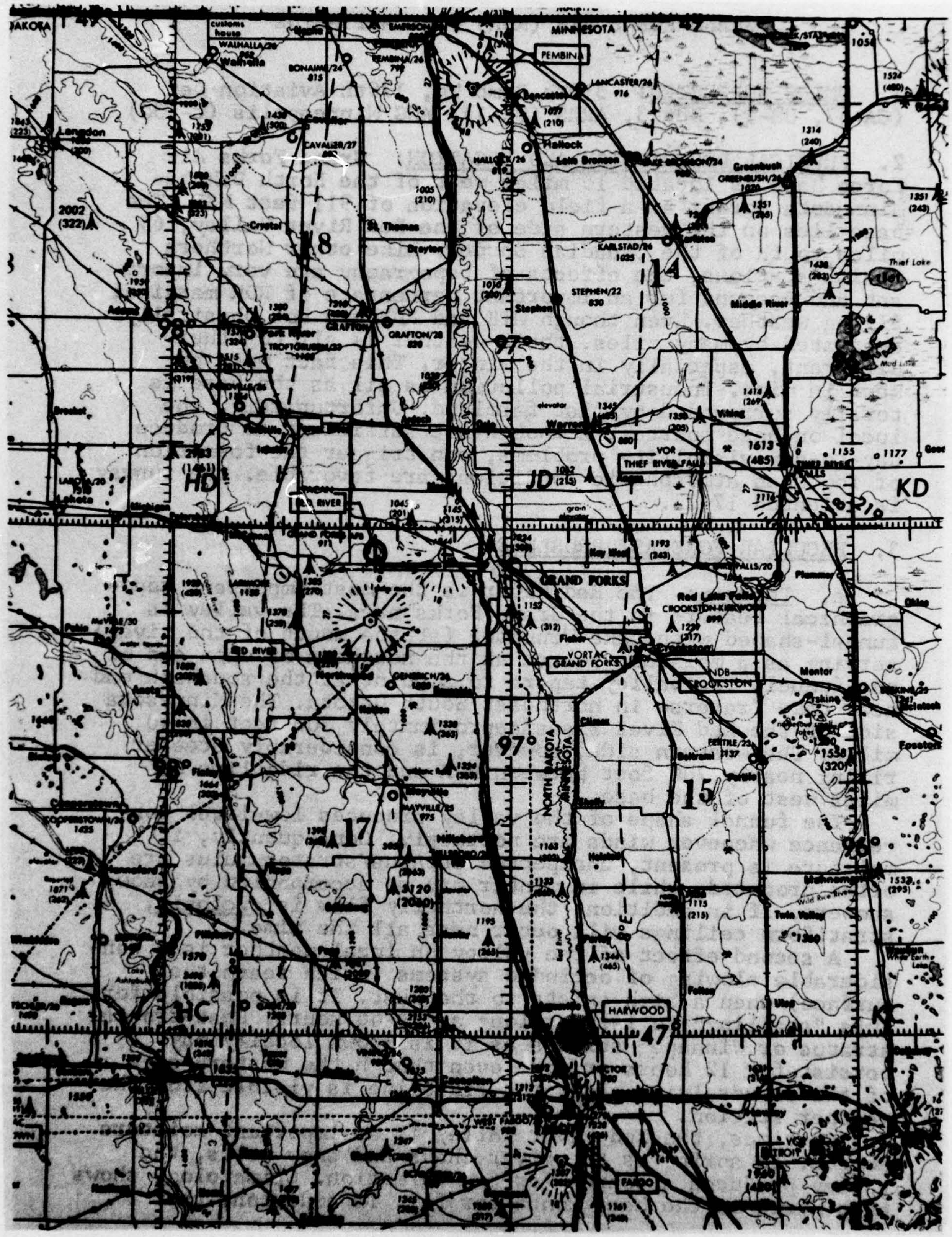
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The Red River is the most important topographical feature in the Grand Forks area. The valley is funnel-shaped with Lake Winnepeg (at the mouth of the river) serving as a moisture source at the northern or open end of the funnel. The valley tapers to a point at the southern end near Lake Traverse in northeast South Dakota. The Minnesota side of the Red River rises approximately 300 feet in 40 miles. The western side, however, is considerably steeper rising nearly 700 feet between RDR and the ridgeline 30 miles west of the base.

The funnel shape of the valley produces low-level convergence whenever winds are northerly. Consequently, if moisture is present, unexpected stratus/stratocumulus are often produced, while in winter may be accompanied by snow showers. If in addition, the northerly flow is cyclonic, stratiform ceilings will occur near all the time.

A second effect of the valley on local weather is a considerable slowing of occluded systems (which reach the surface) when a high exists to the west. It is possible for this "stalling" to last as long as 24-48 hours. Post-frontal stratus or Winnepeg stratus as it is known locally may persist for 12 hours or more even though the western edge of the clouds lying along the ridgeline is visible from the weather station.

At times, the Red River Valley is an important moisture source. In spring as the river thaws and snow melts, the valley produces a source for fog formation. Climatology shows that March is the best month for fog. In addition, the


MINNESOTA
PEMBINA
Langdon
Hallock
Lake Bronson
Greenbush
Crystal
St. Thomas
Drayton
KARLSTAD/26
Thief Lake
Middle River
Stephen
STEPHEN/22
GRAFTON/26
Warren
Viking
VOR
THIEF RIVER FALLS
HD
JD
KD
RED RIVER
GRAND FORKS
Red Lake Falls
CROOKSTON-KIRKWOOD
VORTAC
GRAND FORKS
NDB
CROOKSTON
Mentor
Climax
Beltrami
NORTH DAKOTA
MINNESOTA
MAYVILLE/25
Mahnomen
Twin Valley
HC
HARWOOD
KC
FARGO
8
14
15
17
47
97°

cooling of moist southerly or southeasterly flow (mild upslope to the base and all of the missile complex to the west) as it moves northward will produce fog and stratus over much of the area.

The depth of the Red River Valley is sufficient to retain a pocket of cold air. At times, such a cold air layer may persist for several days. Therefore stratus may occur in the valley not experienced elsewhere. Considerable low level instability may allow strong winds at gradient level to blow right over the inversion.

4. <u>SYNOPTIC TYPES AND FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction and Section 4 of the Minot Forecast Guide. There are some important exceptions as noted below.

a. With A and E types, especially when there are strong northerly winds forecast behind continental fronts, the low C category ceilings will stay in much longer than at MIB (assuming the wind is NW-N at MIB). This is especially true in the early and late winter season when Lake Winnepeg is not frozen.

b. With C and D types when strong lows are caught in the Great Lakes, local convergence will often cause the ceiling at RDR to be one category lower than MIB. Also greater proximity of the Lakes will cause more snow shower activity.

c. With C and D types when strong lows are over the Lakes, winds will be considerably stronger for a longer period than at MIB.

d. With Type B, or when a Type A or E returns cold air off the Rockies in the form of a warm front, the boundary may override the cold air in the Red River Valley. Subsidence of the warmer air over the cold air may cause stratus and fog to form.

e. As with MIB, the track of low centers with respect to the station is critical. It would be possible under these conditions to get different ceilings at the two stations.

f. When northeasterly winds are produced with weak cP fronts to the south such as Type Y in the summer or some form of stationary boundary to the south, MIB is very prone to upslope stratus. RDR may have nothing under these conditions.

5. <u>SEASONAL FORECAST RULES</u>:

<u>WINTER</u>

<u>FOG</u>

a. The three synoptic situations most often accompanying

fog at Grand Forks are: the valley lies in a col region, the valley lies in the moist return flow on the trailing edge of a polar high and a weak occlusion stalls in the vicinity leaving RDR in the frontal boundary between an mP and a cP (or possibly mT) air mass.

b. The winds occurring with fog are nearly always northeast to southeast at 7 knots or less; however, fog occasionally occurs with a northwest wind when an occlusion stalls in western Minnesota. The morning preceding fog at RDR is usually marked by fog in southern Minnesota, South Dakota or northern Iowa. This is an indicator of the approach of low level moisture and should alert the forecaster to the possibility of fog 24 hours in advance.

c. Case studies indicate that the best way to forecast the onset time of fog is to look upwind for fog and stratus and advect it to the base. Diurnally, fog generally forms between 0200-0500L and dissipates rapidly after sunrise; however heavy fogs do not dissipate before 1100L.

d. During the winter, induced ice fog may cause brief visibility restrictions when cA air masses drop temperatures below -20°F. Visibility may be reduced below three miles between 0700-0800L by automobiles. In addition, runway visibility will drop to near zero for several minutes following aircraft takeoffs on such cold mornings.

FREEZING PRECIPITATION

a. Though an infrequent occurrence at Grand Forks, it is an important forecast problem. In a matter of minutes after its onset, freezing precipitation can reduce the RCR from dry to IR02 or less and bringing aircraft operations to a standstill. Freezing precipitation has occurred at RDR from October through April; however, December has nearly three times the number of occurrences as any other month.

b. The synoptic situation most often producing freezing precipitation in the local area is as follows:

(1) A shallow tongue of cP air overlying the valley.

(2) A stationary front to the south or slow-moving warm front approaching from the southwest.

(3) Moist mP air overrunning the cP air.

(4) Surface temperatures in the 20-32°F range.

(5) Freezing level aloft between the surface and 850 mb.

ALL SEASONS

a. Forecast surface wind gusts to 35 knots or greater only if the pressure gradient through RDR is greater than 12 mb per 5° latitude and the second standard level winds are equal to or greater than 35 knots in the Red River Valley.

b. When the thermal parameters in 3WWg Tech Note 73-4 indicate snow as opposed to rain, forecast rain as long as the surface temperature is greater than 35°F, and forecast snow when the temperature drops to 35°F or colder.

c. Winter-spring: With a high pressure ridge at the surface through the North Central Plains and an intense low to the east or northeast, forecast C category ceilings for as long as RDR is in the cyclonic flow.

d. Summer-autumn: Forecast "Winnepeg Stratus" (or stratocumulus) 1,000-4,000 feet the morning following an occluded frontal passage when low-level moisture is present.

ELLSWORTH AFB (RCA) FORECAST GUIDE

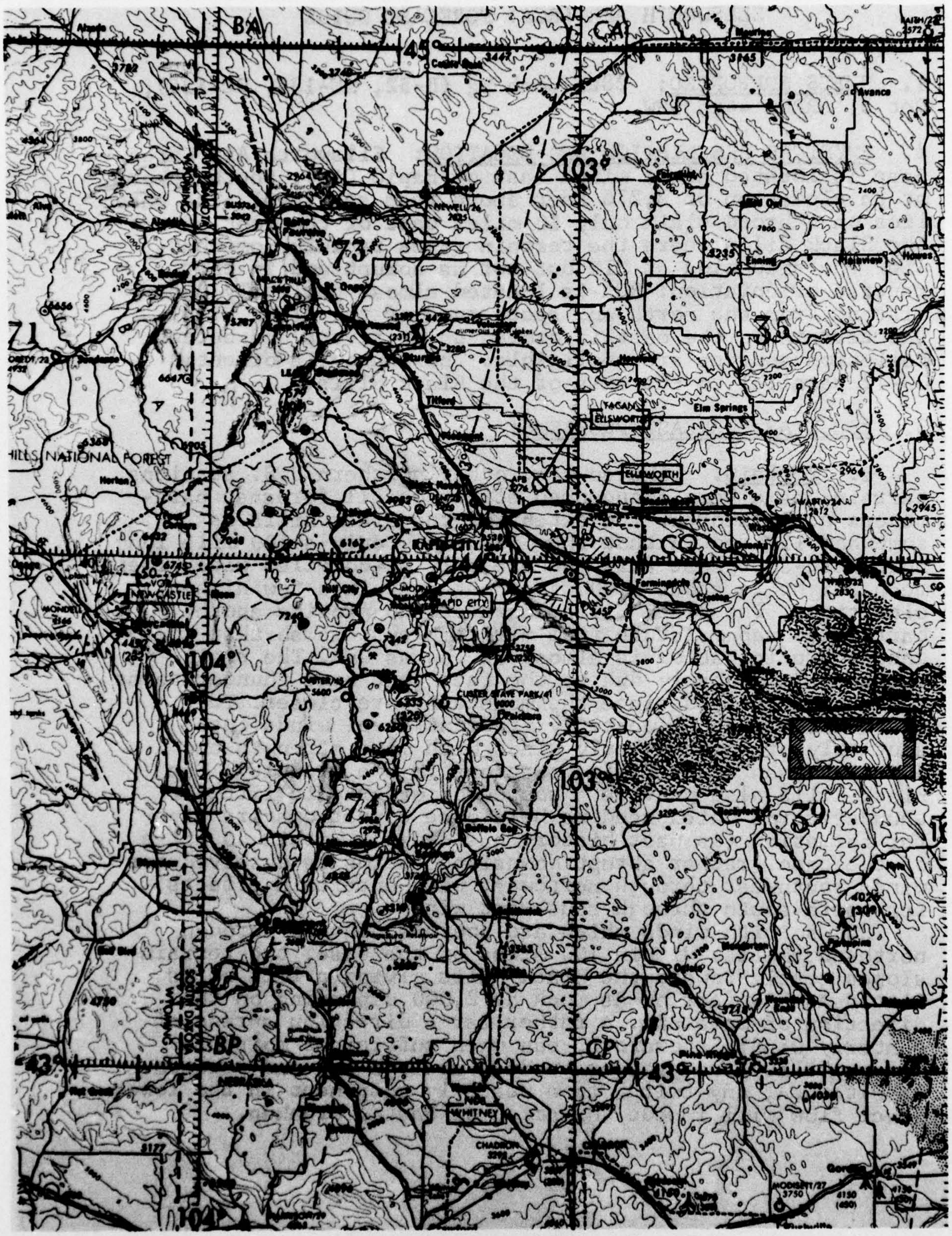
1. UNITS SUPPORTED: 28th Bomb Wg (B-52, KC-135, EC-135), Det 3, ARRS. 44th SMW.

2. PHYSICAL DESCRIPTION AND LOCATION: Ellsworth Air Force Base is located eight miles east of Rapid City, South Dakota at an elevation of 3,276 feet above mean sea level. The base lies on a broad plain only 10 miles east of the foot of the Black Hills where the terrain rises rapidly somewhat like the situation at HIF but not as abrupt and in the reverse orientation. RCA is located almost perfectly equidistant from the north and south ends of the Black Hills. The terrain to the east is broken up by rivers and buttes. Pollution sources are negligible. The runway is oriented 30-12 parallel to the axis of the Black Hills.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Like so many other northern U.S. stations, terrain has a very pronounced effect on all forecast parameters at Ellsworth. The extent of the Black Hills is somewhat limited in that they lie along only a 100 mile long northwest-southeast axis and are only 40-60 miles wide. Their mean height is about 5,000 feet but contain a few higher elevations. The Black Hills, however, do provide another barrier to sap moisture from maritime systems so that the annual precipitation is almost as low as GFA. The small increase is probably due to the fact that more thunderstorms get over the field since the mountains are closer. The Black Hills channel westerly gradient level winds into southerly or northwesterly winds with more strength and duration than other Plains stations in the vicinity. The Black Hills also provide a source of orographic lift for thunderstorms which need no help once conditions are ripe for formation (as past history has shown). Within 50 miles of the base, rather abrupt downslope motion is observed for winds southwest through northwest with uncertain effects for north-south through southwest winds.

Not so with winds which are south-southeast through north-northeast. Within 100 miles of the base, the terrain slopes gently toward the Black Hills giving a lift of as little as 500 feet or as much as 2,000 depending on the direction of movement. A rather large direction spread of easterly winds, therefore, can when sufficient moisture and stability are present produce upslope fog and stratus. As with GFA, any switch to a westerly component in the lower level flow will impede formation or hasten breakup.


BA
CA
103°
73
35
71
HILLS NATIONAL FOREST
NEWCASTLE
ELLSWORTH
Elm Springs
104°
74
39
BP
CP
43°
WHITNEY
CHADRON

b. Air Masses: The dominant air mass in winter is cP which is partly or completely replaced frequently by mP; moving in from the west in turn becoming cP very rapidly by modification processes. cA fronts occur occasionally bringing bitter cold and possible blizzard conditions. mP dominates in the summer but rapidly changes to cT as it has been dried considerably by passage over the mountains to the west.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A:

(1) Clouds: Broken to overcast middle cloud in high D or E category 4-6 hours ahead of front reaching low D category in the frontal zone. If a cP or cA is following, expect intermittent B category about 800 feet for several hours after the front passes, longer if an upslope situation is anticipated. Clearing is normally eight hours after the continental front goes by.

(2) Visibility: Unlimited except 1-3 miles in snow and blowing snow persisting until the precipitation ends.

(3) Precipitation: Light snow, possibly moderate if low center passes close to station. Less than two inches. Two to four inches with low center closer to station or sustained upslope in existence.

(4) Winds: WSW to S 20-25 knots ahead of mP front. Gusts behind front up to 45 knots which may last up to 8 hours.

b. Type B: Series of fronts moving eastward across southern Canada with low centers north of Border. Fronts pass RCA from the north-northwest. Portions of the Great Basin High break off and cross station behind fronts. Continental fronts are not likely with these systems as upper flow is nearly zonal with weak trough off West Coast.

(1) Clouds: Broken to overcast middle clouds in E category 6-8 hours ahead of front - may become low D in frontal zone with intermittent C category ceilings after passage for a few hours.

(2) Visibility: Unlimited except C category in snow or blowing snow for a few hours after frontal passage.

(3) Precipitation: 1-2 inches of snow.

(4) Winds: WSW-NNE-SSE depending on orientation of lee-side trough 15-20 knots ahead of front. NW gusts to 25-35 knots after passage for 6 hours.

c. Type C: California Low pattern is normally handles by passage of cP or cA front at RCA regardless if low comes out of southwest or not. Slow-moving cold front works its

way southward into the 500 mb trough position. The front curves northward again across central Nebraska to east of RDR. Surface lows move from the Texas Panhandle northeastward through strong southwesterly flow to the northeast. Minor troughs aloft are oriented north-south moving up through the flow. Reflection of these troughs is not seen in the surface isobar pattern especially. Continental air becomes stationary against the Rockies with front between it and the PB air on the other side.

(1) Clouds: Clear at first, becoming C category as clouds form a few hours after frontal passage. Can be B at times especially if upslope snow is widespread. Clouds are apt to persist from 36-48 hours to several days. Middle cloudiness increases at 30 hour intervals as troughs aloft pass the station, This does not affect low clouds but tends to increase any precipitation.

(2) Visibility: 1-3 miles in snow showers; unlimited otherwise.

(3) Precipitation: Light intermittent snow usually accumulating less than one inch.

(4) Winds: NW 30 knots with passage. May gust as high as 45 knots and persist. Increases likely each time a trough passes (tightening surface pressure gradient).

d. Type D: Normally presents no problem as long as track is from eastern New Mexico to Nebraska. When this happens, treat like the weather of Type C (cP air enters system moving out into the Central Plains). However, a strongly building ridge over the Mississippi Valley can prevent the low from moving along a normal track and deflect the Colorado Low northeastward (or northward) so its center goes through central or western Nebraska. This gives RCA a blizzard. The following applies only to the latter situation.

(1) Clouds: Overcast stratus in low B or A category in heavier snow. Low ceilings will persist until low reaches Canadian Border and drifts further into Canada. Ceilings will go to a low C with intermittent conditions into B in snow. As long as the intense low remains in southern Canada, these conditions will persist.

(2) Visibility: 1-3 miles in light snow. Near zero in blowing and drifting snow. Conditions will continue intermittently until low leaves southern Canada or dissipates.

(3) Precipitation: As much as one foot of snow. Accumulation may be hard to measure due to its sideways moving nature.

(4) Winds: ESE-NE 25-40 knots backing as storm moves into South Dakota or western Minnesota but continuing as long as deep low center persists in southern Canada.

e. Type E or E_s: The upper air pattern is simplicity itself. Strong ridging is present over western Canada with troughing to the east. Strong northwesterly flow is present. At the surface, cold fronts pass RCA from north through east. Great Basin High is unusually strong. Lows moving through the eastern Great Lakes and up the St. Lawrence drag polar outbreaks southward (1035 mb or greater) east of the Rockies.

(1) Clouds: Broken to overcast C or high B category ceilings with front up to six hours. If snow is expected, forecast straight B.

(3) Precipitation: Short periods of light snow less than two inches.

(4) Winds: N 30-40 knots with higher gusts after front. Can persist up to 24 hours.

SUMMER

a. Types B and E: These patterns predominate with strong E patterns quite rare. mT air is replaced regularly by fresh mP less often by cP.

b. Type Y: Weak ridging in central Canada with near zonal but weak flow over RCA. High over Great Basin is stronger than normal (for summer). cP high over Manitoba or Great Lakes drifting SSE or stationary. Upslope conditions exist and are apt to last for days.

(1) Clouds: Overcast stratus forming around 0600Z and remaining through mid-morning. Usually is in B category, possibly A. Watch for middle clouds as this will increase the length of time needed to break up the clouds.

(2) Visibility: B or C category depending upon precipitation. 5-7 miles in afternoon. A category is possible if winds are very light near sunrise.

(3) Precipitation: Trace drizzle or late and early season snow flurries.

5. SEASONAL FORECAST RULES: Winter (Also apply to summer).

a. Do not forecast high D ceilings with a Type B system in advance of the front. It is extremely difficult to hit accurately.

b. If a cold front is moving rapidly southward from RCA into Nebraska, low ceilings and visibility will be temporary.

c. Stratus in any form will dissipate when the surface and gradient wind becomes southerly accompanied by falling sea level pressure.

d. When cP or cA air exists over RCA and stratus is in, precipitation will begin or increase in intensity as a trough aloft passes LND.

e. Pressure falls at RCA are usually accompanied by southerly flow.

f. Winds will be less than 25 knots with a westerly flow (240-290) and will be quite variable when the upper air flow below 8,000 feet is westerly.

g. When a deep low pressure cell passes between RCA and 55°N, the winds will be equal to or greater than 25 knots.

h. In a Type D pattern, the snow will usually cease at RCA when the surface low has moved out east of the MKC-OMA-YKN line.

i. When a cold front is between MLS and RCA, subtract the RCA 3-hour pressure change from the MLS 3-hour pressure change and multiply by 10. This will give the expected gust with frontal passage.

REGION 4

CENTRAL PLAINS FORECAST GUIDES

Peterson Field	COS
Fort Carson - Butts AAF . . .	FCS
Buckley ANGB	BKF
Offutt AFB	OFF
Fort Riley - Marshall AAF . .	FRI
Richards-Gebaur AFB	GVW
Whiteman AFB	SZL

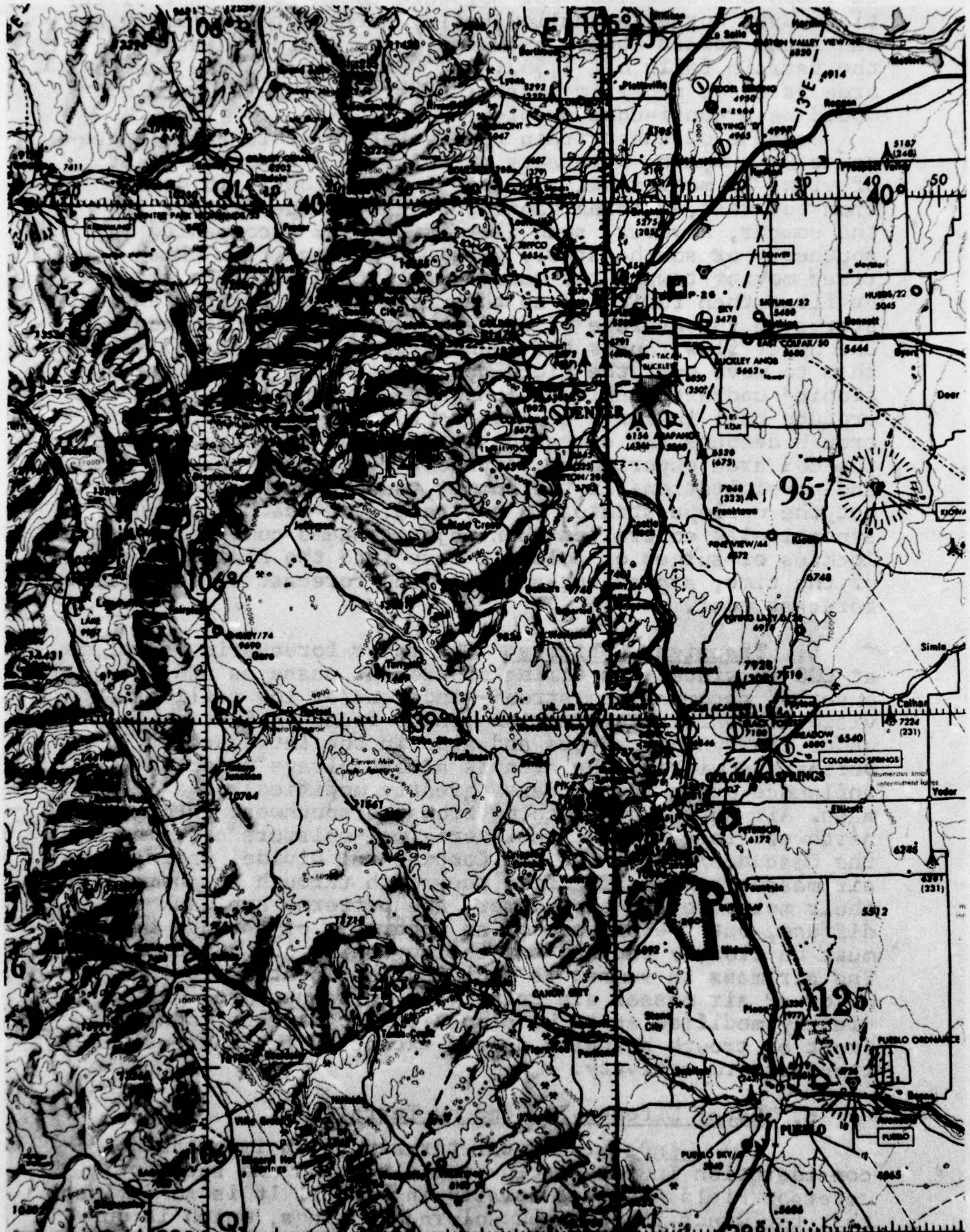
PETERSON FIELD (COS) FORECAST GUIDE

1. UNITS SUPPORTED: MAS (T-39), Transient Aircraft

2. PHYSICAL DESCRIPTION AND LOCATION: Peterson Field is located a few miles east of the city of Colorado Springs. Peterson Field is co-located with the civilian airport, and hence, the ICAO identifier is the same for both. The city and airfield are located at the base of the most easterly range of the Rocky Mountains. There are no bodies of water in the area large enough to have any effect on the local weather. Elevations rise rather abruptly to the north and west, while to the east the land drops off gradually into the Central Plains. The field is located at an elevation of 6,172 feet, and the principle runway orientation is 36-18 with an alternate 31-13. The surrounding country is semi-arid except where irrigation exists. Urbanization is heavy on the west side of the base toward the mountains.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Forecast problems and, indeed, the entire climatology of the COS area are made by terrain. To say that the base lies in the "rain-shadow" of the Rockies is a gross understatement, yet paradoxically this same terrain configuration brings much, or is responsible for, much of the precipitation observed at COS. The base lies almost directly east of Pikes Peak, about 25 air miles. At an elevation of 14, 310 feet, this features looms over the surrounding countryside and is the highest point in this portion of the so-called "front" of the Rockies. From Pikes Peak, mountains of varying heights extend north and south in the Front Range. To the west, chains of north-south oriented mountain ranges lie at varying intervals all the way to the Pacific Ocean. From the air, COS reveals a rather simplistic terrain profile much like HIF only in reverse. Such is not the case when one studies the area closely. To the north of the station about 30 miles lies an east-west ridge (Palmer Ridge) which has a center elevation of 7,923 feet. Although this feature is only 1,800 feet higher than COS, its orientation blocks the movement of moist air northward when the surface flow is south or southeast. It also affects the movement southward of cold air along the slopes. It is possible for this ridge to delay the entry of cold air into the COS area (especially if the cold air is shallow), instead deflecting the winds to a more easterly or southeasterly direction (upslope). This explains why, in some cold air outbreak situations in the absence of precipitation, that BKF will not go down but FCS and COS will. Except for Palmer Ridge, the general terrain is about the same as BKF. The Rockies rise abruptly 20 miles to the west. To the east except for a small rise 10 miles out, the land gradually drops off providing a per-


DENVER
COLORADO SPRINGS
PUEBLO
PUEBLO ORDNANCE
Franktown
Ellicott
Fountain
Yoder
Simla
Calhan
Bennett
Eleven Mile Canyon Reservoir
13°E
95
125
40°
38°

fect upslope situation for moisture coming from that direction. Even worse, a shallow valley extends to the southeast and south toward Pueblo 65 miles away. In that distance, the terrain falls off 1,500 feet. Fortunately, the Pueblo area is not a prolific moisture source, or this upslope would be a continuous problem.

Because of the terrain configuration, this takes precedence when making forecasts at COS from a synoptic point of view. In most zonal situations when flow is in depth from the west, nothing happens at all in the winter. In the summer, however, such flow is usually accompanied by southerly or southeasterly gradient-surface flow which rises moving toward the mountains lifting moisture slowly at first then radically up the Front Range, forming thunderstorms on the average of 70 days during the summer months. The upper flow causes the thunderstorms to shear and allows them to move over the field and potentially to produce a sloping updraft configuration which is generally known to produce hail in large quantities through mid-July. If a trough deepens and comes out through the southern Rockies, the COS area experiences very poor weather in upslope stratus and precipitation. In the summer, such troughs are rare, but the upslope stratus is not rare. COS weather is only synoptically controlled when major systems come through the Rockies or surges of cold air move into the Plains. The rest of the time, a gradient-surface wind forecast is the primary forecast tool.

b. __Transient Controls:__ The major forecasting problems at COS in winter are timing of frontal passages and the onset of accompanying strong winds and/or low ceilings and visibility. This information can be found in Section 4 under the Synoptic Types and also in the Introduction. During the winter, the area is almost always under the influence of an mP air mass (greatly modified) or a cP air mass. Air masses approaching from the southwest through northwest lose most of their original moisture crossing the Cascades/Sierra and the Continental Divide, whereas air masses approaching from the north through south maintain their moisture. In the summer, the patterns are weak and diffuse, but the passage of an upper air or surface trough must be closely watched for the beginning of thunderstorms. The air mass in summer is modified continental tropical. mP or cP air masses are relatively infrequent and are so greatly modified as to be almost unrecognizable when the front or trough actually passes except by the increase of thunderstorm activity.

c. __Local Effects Induced by Terrain:__

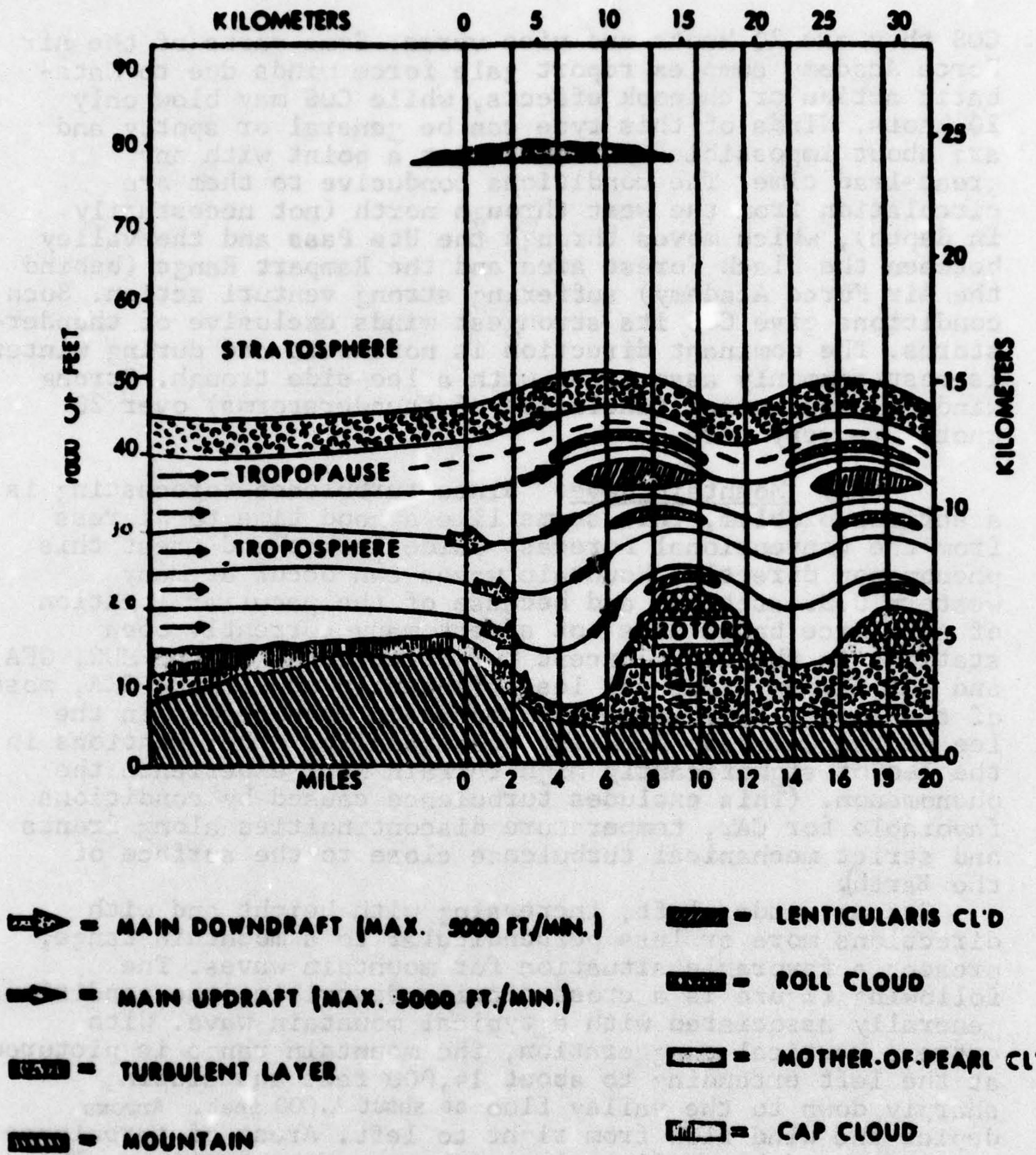
(1) __Winds:__ The local terrain is an important consideration in forecasting the direction and speed of Peterson Field winds especially in winter. It is so dominant that the winds in downtown Colorado Springs, which is only six miles west and lower in elevation, can be calm while at

COS they are 20 knots and vice versa. Some parts of the Air Force Academy complex report gale force winds due to Katabatic action or chinook effects, while COS may blow only 20 knots. Winds of this type can be general or spotty and are about impossible to forecast at a point with any great lead time. The conditions conducive to them are circulation from the west through north (not necessarily in depth), which moves through the Ute Pass and the valley between the Black Forest area and the Rampart Range (behind the Air Force Academy) suffering strong venturi action. Such conditions give COS its strongest winds exclusive of thunderstorms. The dominant direction is northwest and during winter is most commonly associated with a lee-side trough. Strong winds in the summer (exclusive of thunderstorms) over 20 knots are very rare.

(2) Mountain Wave: Since turbulence forecasting is a serious problem, this seems like a good time to digress from the conventional Forecast Guide format and treat this phenomenon directly. Mountain waves can occur at many western U.S. stations and because of the peculiar location of Air Force bases does not affect many currently open stations in the CTFP. Except for occurrences in the MUO, GFA and RCA flying areas and less frequently at HIF and SKA, most of the severe turbulence from mountain wave occurs in the lee of the Colorado Rockies. Occasionally, other stations in the lee of significantly high terrain will experience the phenomenon. (This excludes turbulence caused by conditions favorable for CAT, temperature discontinuities along fronts and strict mechanical turbulence close to the surface of the Earth).

Strong winds aloft, increasing with height and with directions more or less perpendicular to a mountain range, present a favorable situation for mountain waves. The following figure is a cross-section describing the conditions generally associated with a typical mountain wave. With extreme vertical exaggeration, the mountain range is pictured at the left extending to about 14,000 feet and sloping sharply down to the valley floo at about 4,000 feet. Arrows depict the wind flow from right to left. Areas of turbulence are indicated by small curls as shown in the captions. The dot-filled arrows indicate the position , relative to the mountain, where strong downdrafts occur. The solid areas indicate the updraft areas.

The cloud types shown in the figure are more or less peculiar to the mountain wave. There are the cap (foehnwall), rotor or roll cloud, lenticular and mother-of-pearl clouds. The cap cloud hugs the tops of mountains and flows down the leeward side giving the appearance of a waterfall. This cloud is dangerous because it hides the mountain top and is



CROSS SECTION OF CONDITIONS ASSOCIATED WITH A TYPICAL WAVE.

in the strong downdraft area on the lee-side of the peaks. These downdrafts can be as strong as 5,000 feet per minute.

The rotor cloud, which looks like a line of cumulus or fractocumulus clouds parallel to the ridgeline, forms on the lee side with its base at times below the mountain peaks and its top extending considerably above the peaks, sometimes merging with the lenticulars above and forming a solid layer up to the tropopause. The rotor cloud is effectively a stationary cloud, constantly forming on the windward side and dissipating on the leeward side with a constant boiling motion within and below the cloud. While often apparently harmless looking, the rotor cloud is dangerously turbulent with updrafts of up to 5,000 feet per minute on its leading edge and equivalent downdrafts on the opposite edge.

The lenticular or lens-shaped clouds, which sometimes appear in layers extending to 40,000 feet, are usually relatively smooth due to the laminar flow in this section of the wave. At times, however, a breakdown of the laminar flow sets off the formation of severe turbulence throughout the whole depth of the wave. When this happens, the highest lenticular clouds show very jagged, irregular edges rather than the normal smooth edges. These lenticular clouds, like the rotor clouds, are essentially stationary constantly forming on the windward side and dissipating on the leeward side. The mother-of-pearl cloud is an extremely high-level lenticular cloud appearing at about 80,000 feet in the polar regions under wave conditions.

The wave clouds can extend several hundred miles parallel to the ridgeline, and there may be several wave crests, with the amplitude and intensity of the waves decreasing downstream. There are numerous times when the wind is favorable for a wave condition, but there is not enough moisture present for the clouds to form. This cloudless or "dry" wave gives just as much turbulence as when clouds are present but none of the warning features that the clouds can provide.

The most favorable wind profile for the existence of a mountain wave has a wind component perpendicular to the mountain range exceeding 25 knots at the mountain top level (with 50 degrees being the maximum deviation from the perpendicular). The strongest winds occur, of course, with a strong perpendicular flow. There should be a rapid increase in the wind speed with altitude at the level of the mountain tops and for several thousand feet above, with a steady flow (strong) up to the tropopause. However, an extremely strong increase in wind speed with height can eliminate the wave and leave only stagnant air in the valley.

(3) <u>Upslope Stratus</u>: Low-level winds from the northeast through south are "upslope" winds which may or may not

depending on the moisture content of the air, produce low ceilings and/or precipitation and fog in the local area. Operationally, we are most concerned with IFR conditions which occur very rarely unless the prevailing surface wind is 090-190° inclusive. The foregoing statement is not true of widespread cloudiness associated with an air mass behind a frontal system but is true only in cases where the formation of clouds is due to orographic effects. The types most associated with upslope stratus in winter are C (lesser degree), D and E. In the summer, upslope stratus can occur anytime a weak polar anticyclone exists over the Northern Plains or Lakes area with a weak front up against the Rockies. Subsequent movement eastward of the lee-side trough will break up this stratus in the COS area.

(4) Thunderstorms: The cyclic nature of thunderstorms during the active season (May through early August) is very interesting. Thunderstorms are observed at mid-afternoon one day, then in the evening the second day. On the third day they may not be observed at all, while on the fourth the cycle repeats itself. Although no description of what happens seems to be in the literature, a possible explanation follows. On the first day, there is no residual moisture in the mountains from the previous day's activity, so the formation is due to lift and heating only. These storms are high enough to rain at mid-day on the west slopes of the Front Range. Their movement is eastward while residual middle clouds hang back over the west slopes. Development continues out off the mountains with rain and high winds occurring late in the afternoon or in the evening. On the second day, the clouds build rapidly on the west slopes due to the moisture on the west slopes from the previous day. But the same thing also occurs out over the Plains where there is also moisture from the previous evening (in selected spots). As a result, building occurs very rapidly and the storms reach above mountain top too early to rain in the COS area but instead charge on eastward and cause problems in eastern Colorado. On the third day, there is no residual moisture anywhere and normalcy returns to the thunderstorm development. This explanation applies only to the diurnal pattern. If a trough is in the area, that will complicate the situation.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

WINTER

a. Type A: Fronts trailing from Alberta Low may reach the COS area giving a possible upslope condition but less likely than [illegible].

(1) Clouds: E category middle may develop along boundary with some cumulus over the mountains. Upslope conditions as described in Type E apply to a lesser extent.

(2) Visibility: Unrestricted unless upslope conditions prevail.

(3) Precipitation: None.

(4) Winds: NW 5-10 but watch out for katabatic action developing if Basin High is especially strong in central or southern Colorado.

b. Type B: Stronger Basin High than Type A with portions breaking off and moving into Plains. Zonal flow dominates, but main jet well north of area. Turbulence situation is possible.

(1) Clouds: Heavy middle and high but in E category. Short periods of scattered stratocumulus may develop as highs move into Plains and flow becomes southeasterly.

(2) Visibility: Unrestricted.

(3) Precipitation: None in winter.

(4) Winds: WSW 10-15 shifting to NW 10-20, then becoming variable to southeast at 5 knots.

c. Type C: Deep California Low leaves polar front stranded south of COS and up along mountains. Main jet aloft over New Mexico. Polar outbreaks are weak into Plains, but highs are of sufficient size to keep shallow cold air in COS area. Waves form on front and move northeastward. A major system may come out of upper trough. If so, treat like type D with center south of station.

(1) Clouds: With weak waves, forecast B category stratus and consider the possibility of it being low enough to be below minimums (if sufficient moisture present). Stratus will not break until winds become more north or northwest.

(2) Visibility: Unrestricted unless precipitation occurs (likely category D). Heavier precipitation with major system will cause category B restriction.

(3) Precipitation: Very light unless major system comes out of Southwest, in which case snow will occur for 12-18 hours.

(4) Winds: SE 5-10 becoming NE 10-20 at times (higher with major system). Winds will shift back to southeast again and stay that way until lee-side trough develops and pulls cold air off the slopes.

d. Type D: Classic Colorado Low forms in the central or southern Rockies and tracks into the Plains. Jet develops over surface system and makes a good case for turbulence. If the center of the low is north of COS, expect weather similar to Type B with moisture possibly getting in from

the southeast. If the center is south of COS, a much different situation develops.

(1) Clouds: Heavy category E middle and high lowering to D as precipitation starts with rapid deterioration to B as low reaches the Continental Divide. If center is north, DO NOT forecast category D cloudiness but watch for upslope moisture advection from the Gulf and/or thunderstorm induced ceilings in the spring.

(2) Visibility: Unrestricted except category B in heavy precipitation if wave is south of station.

(3) Precipitation: Heavy snow for 8-12 hours, rapidly tapering to snow showers. If strong cP front moves through the area, precipitation may increase once more before quitting completely. Wave north - no precipitation.

(4) Winds: NW 5-10 becoming NE-SE 10-20 with higher gusts as winds gradually back to NW. Wave north of station, wind will remain SE and increase shifting to WSW through NW 10-20 knots.

e. Type E: Classic polar outbreak into Plains will reach COS, although if not deep may come around Palmer Ridge and in from the ENE. If the front passes the station with sufficient moisture behind it, clouds and precipitation are possible.

(1) Clouds: Stratus ceilings (category C) may form and break up, forming again the following morning until the moisture dries up. Basic category C ceiling will be B if it snows.

(2) Visibility: Unrestricted unless precipitation occurs, even then only for a short duration.

(3) Precipitation: None unless outbreak is strong.

(4) Winds: SE 5-10 will increase rapidly prior to frontal passage shifting to NE 10-20 with possible higher gusts.

SUMMER

a. Type B: Weak diffuse systems shown perhaps only by the passage of a trough aloft with the maritime front reforming east of the station.

(1) Clouds: Intermittent category E ceilings becoming short periods of D (largely unforecastable except as intermittent) 6,000-8,000 feet or C in very heavy thunderstorms (because of precipitation).

(2) Visibility: Unrestricted except in precipitation.

(3) <u>Precipitation</u>: Thunderstorms form on the mountains and are blown over the field by the upper winds after reaching the glaciation stage (sufficient altitude). Whether the shower will actually occur right at the station is a difficult forecast problem restricted to afternoon and evening.

(4) <u>Winds</u>: Variable to N 5-10, 10-15 knots afternoon becoming variable at night. Surface heating alone rarely produces gusts over 20 knots.

b. <u>Type E_S</u>: Although not specifically a winter type that occurs in the summer, a ridge of high pressure in the Northern Plains in combination with a weak system moving through New Mexico can produce an inverted trough giving upslope stratus.

(1) <u>Clouds</u>: If inverted trough exists along slopes, moisture is likely from the Gulf. Category B stratus in the morning rising slowly during the day and back right down again at night persisting as long as the upslope regime exists, perhaps 4-5 days.

(2) <u>Visibility</u>: Category B or C in fog associated with stratus. Category A can occur with drizzle.

(3) <u>Precipitation</u>: Drizzle possible especially if a weak vertical motion field exists.

(4) <u>Winds</u>: E through S 5-10 knots.

c. <u>Type Y</u>: Large high pressure cell in Lakes or Northern Plains. Weak cP front against mountains can produce the same conditions as Type E_s above.

5. <u>SEASONAL FORECAST RULES</u>:

<u>WINTER</u>

a. Type E fronts (polar outbreaks) sometimes will appear to stall out south of Denver probably because of the Palmer Ridge. This slowing down is most noticeable during daylight hours, and forecasting the time of passage of these fronts is very difficult to determine. When large areas of cloud and precipitation exist behind these fronts, it takes 2-3 hours for the ceilings to develop in the COS area. Watch out for the upslope component developing even if there appears to be insufficient moisture behind the front.

b. Do not forecast a frontal passage from the north or northwest with the 500 mb ridge between 105W and 117W.

c. Type B fronts will not produce significant ceilings below category E and precipitation is unlikely.

d. Backdoor fronts usually produce low B or A category ceilings about 3 hours after passage.

e. Surface or 500 mb lows passing north or northwest of COS may cause strong winds but no cloudiness or precipitation.

f. Post-frontal ceilings with N-NE winds are seldom B or lower unless precipitation occurs.

g. Upslope will not develop with a surface high or ridging in eastern Colorado.

h. Do not forecast upslope with a split high. (Assumes that the lee-side trough exists, and no cold air is backed up against the mountains).

i. Forecast upslope to persist for 24 hours or more when the central pressure of the high is greater than 1035 mb. (This assumes that the upslope condition has already started).

<u>SUMMER</u>

a. In the absence of definite pressure systems, forecast a diurnal wind of south during the day and north at night and early morning.

b. If middle clouds are reported near sunrise, there is a better than a 75% chance of afternoon thunderstorms.

c. Forecast thunderstorms if an early morning cloud cap is observed over Pikes Peak.

d. Forecast thunderstorms if both the 12Z GJT 500 mb wind direction is 260-280 degrees and the $T-T_d$ is less than or equal to 5 degrees C.

e. If the noon dewpoint is greater than 40^oF, thunderstorms are iminent; if greater than 35^oF, thunderstorms are likely.

(3) Precipitation: Thunderstorms form on the mountains and are blown over the field by the upper winds after reaching the glaciation stage (sufficient altitude). Whether the shower will actually occur right at the station is a difficult forecast problem restricted to afternoon and evening.

(4) Winds: Variable to N 5-10, 10-15 knots afternoon becoming variable at night. Surface heating alone rarely produces gusts over 20 knots.

b. Type E_s: Although not specifically a winter type that occurs in the summer, a ridge of high pressure in the Northern Plains in combination with a weak system moving through New Mexico can produce an inverted trough giving upslope stratus.

(1) Clouds: If inverted trough exists along slopes, moisture is likely from the Gulf. Category B stratus in the morning rising slowly during the day and back right down again at night persisting as long as the upslope regime exists, perhaps 4-5 days.

(2) Visibility: Category B or C in fog associated with stratus. Category A can occur with drizzle.

(3) Precipitation: Drizzle possible especially if a weak vertical motion field exists.

(4) Winds: E through S 5-10 knots.

c. Type Y: Large high pressure cell in Lakes or Northern Plains. Weak cP front against mountains can produce the same conditions as Type E_s above.

5. SEASONAL FORECAST RULES:

WINTER

a. Type E fronts (polar outbreaks) sometimes will appear to stall out south of Denver probably because of the Palmer Ridge. This slowing down is most noticeable during daylight hours, and forecasting the time of passage of these fronts is very difficult to determine. When large areas of cloud and precipitation exist behind these fronts, it takes 2-3 hours for the ceilings to develop in the COS area. Watch out for the upslope component developing even if there appears to be insufficient moisture behind the front.

b. Do not forecast a frontal passage from the north or northwest with the 500 mb ridge between 105W and 117W.

c. Type B fronts will not produce significant ceilings below category E and precipitation is unlikely.

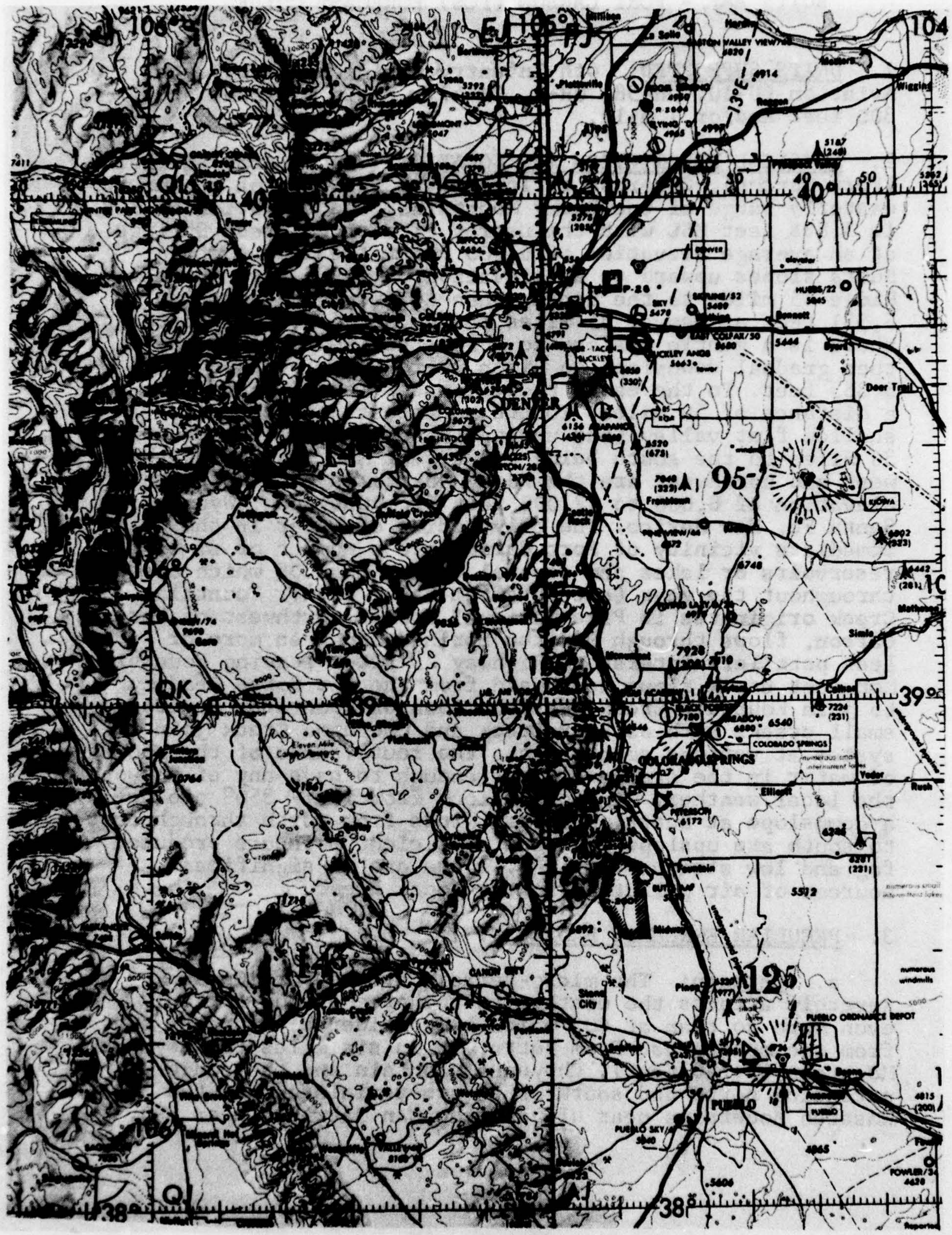
BUTTS AAF - FORT CARSON (FCS) FORECAST GUIDE

1. UNITS SUPPORTED: 4th Infantry Division (Mech), 4th Aviation (U-10, OH-58, UH-1, CH-47). Field minimums are 300 feet and/or 1 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Butts Army Airfield (Fort Carson), Colorado is located at the base of the most easterly range of the Rocky Mountains. The elevation of FCS is 5,838 feet MSL with the nearby city of Colorado Springs at an average elevation of 6,000 feet. The area north of Butts slopes upward to an elevation of 7,923 feet at Palmer Ridge 45 miles to the north, then it decreases again to 5,531 feet at Denver 85 miles to the north. To the northeast there is a gentle upslope to 7,005 feet near Calhan and then gradual downslope to Limon where the elevation is 5,365 feet. To the east, there is near level ground for a distance of 50 miles. To the southeast and south lies a shallow flat valley (but upslope nonetheless), with Pueblo 30 miles to the south being 4,725 feet MSL. To the southwest, west and northwest are the Rocky Mountains with an average elevation of 8,000 to 12,000 feet from Cheyenne, Wyoming to Santa Fe, New Mexico. The only bodies of water in the immediate vicinity of Fort Carson are a number of small reservoirs or lakes and several creeks most of which are dry throughout the year (except after heavy rain). Fountain Creek originates in Pike National Forest northwest of Fort Carson, flows through Manitou Springs and then more or less parallels Interstate Highway 25 after leaving Fountain. Monument Creek flows southward from the Air Force Academy to join Fountain Creek near the town of Fountain. Several small creeks such as Bear Creek and Cheyenne Creek join the system at various points along the route. None of the bodies of water in the area are large enough to have any effect on the local weather. Wind directions from 190°- 350° produce a downslope at Butts. However, winds from north through east to south are upslope and with sufficient moisture produce fog and low stratus ceilings. There are no significant sources of air pollution in the local area.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The micro-terrain around Fort Carson severely affects the weather in the area of the airfield, even more so than at COS which is considerably further away from the mountains. From Butts, it is six miles to Cheyenne Mountain (9,786 feet). Cheyenne Mountain and the range extending north and south of it are reminiscent of the Wasatch Mountains near HIF and the San Gabriels near SBD.



DENVER
COLORADO SPRINGS
PUEBLO
PUEBLO ORDNANCE DEPOT
CANON CITY
Deer Trail
Bennett
Limon
Colfax
Fountain
Peterson
Buckley ANGB
Elbert
Simla
Franktown
40°
39°
38°
104
95
125
13°E

The mountains are very steep on the eastern side facing the base and have a marked effect on ceiling, visibility, winds and thunderstorms. The weather conditions often differ from COS, and the only explanation seems to lie in the terrain itself. Gradient flow moving across Colorado Springs from the northeast must strike Cheyenne Mountain and be deflected so that Butts reports a more northerly or northwest wind. . This is a downslope wind at Butts and might explain why stratus/stratocumulus behind a weak cP or cA front does not always get to FCS. In the case of a strong front, the effect is probably less.

Another potentially difficult terrain feature is Deadman's Canyon to the southwest. When southwesterly flow at 700 mb occurs, the Canyon enhances the surface winds. When upslope flow exists in the Western Plains (out of the southeast), high pressure in southern Colorado causes a drainage wind out of the canyon which is convergent east of the base preventing (in some cases) synoptically produced stratus from developing at FCS. Analyses show in these cases that the lee-side trough appears east of the base due to the misleading convergence. Another possible reason is the fact that FCS lies up out of the river valley to the east away from the natural south-southeast channeling of the wind. High pressure does not always dominate south central Colorado. However, under these circumstances, FCS can be expected to go down in upslope stratus along with COS.

The third interesting feature is Palmer Ridge. Although it is true that the maximum elevations of the Divide occur 45 miles north of FCS, in reality the higher elevations begin at a point opposite the Air Force Academy and extend to a point about 15 miles south of Denver. That makes the "significant" part of the Divide almost 45 miles wide along Interstate 25 tapering off in width and elevation as one heads towards Kansas. The effects of the Divide on COS are reasonably well documented in their forecast guide except for the following which may apply to both stations.

It snows more, longer and is accompanied by low ceilings in the north Colorado Springs area and the Air Force Academy than in other areas especially south of the city. Some of this could be explained by upslope, but upslope exists at Fort Carson also. Some flow may come over Palmer Ridge and some around it from the east converging north of Colorado Springs. Heavier snow could result from such convergence. This same flow could strike Cheyenne Mountain and turn as mentioned previously giving a northerly component to the surface wind and provide it some divergence as well.

There are occurrences of very high winds at night in excess of 50 knots in the COS and FCS area during the winter. These are generally not forecast sufficiently far in advance and are not well understood either. Since all winds line up along the same line north-south at the same time, the

temperatures fall 6-8 degrees with onset and no synoptic fronts are in evidence, one must assume that these are Katabatic winds such as those observed at Boulder. The only logical source regions are the wide bowls of the Palmer Ridge which under strong nocturnal radiation cool at a considerably higher rate than the Plains on either side.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the COS Forecast Guide.

5. SEASONAL FORECAST RULES:

WINTER

a. In the winter and spring when 500 mb winds are 280-320°, strong winds will blow in the south part of the FCS reservation and at COS but not at FCS itself. Light east winds or L/V conditions are likely.

b. With a strong lee-side trough in existence and a high near the Four Corners or in southern Colorado, 35 knots or more out of the southwest is likely.

c. When snow is falling, it will end abruptly with passage of the 700 mb trough.

d. If an inversion exists between 500 feet and 1,000 feet with a 700 mb flow of 30 knots out of the southwest, expect 35 knot or greater surface winds 200-250° at FCS.

e. There is no guarantee that FCS will get the stratus that COS has when a cP or cA front is weak. In the mean, FCS gets a great deal less stratus than COS.

f. Consistently less snow falls at FCS than COS. The duration of snowfall is also shorter.

g. Slowing down of fronts on Palmer Ridge is most noticeable during the day.

h. Forecast snow when conditions are otherwise right, and the 1000-500 progged thickness line is less than 5520 meters; rain otherwise.

ALL SEASONS

a. There is generally a 400 foot difference between ceilings at FCS and COS. (FCS is at 400 foot lower elevation - ceiling therefore higher).

b. Often FCS is open when stratus covers the rest of the High Plains. The surface wind is apt to be 190° rather than 150°. Look at the 850 mb wind; if it is southwest, then FCS may stay open.

c. In the absence of definite pressure systems, the surface winds follow the classic mountain diurnal pattern; southerly 15 knots during the afternoon (upslope) and northwesterly 15 knots at night and in the early morning (downslope).

d. Gusty winds are rare from the east or southeast.

SUMMER

a. Hail is rare at FCS in the vicinity of the base weather station. When hail occurs, it is apt to come from CBs moving from the northwest rather than from the southwest. If hail is going to occur, it will probably be severe rather than 1/4 or 1/2 inch. Hail is especially rare after the beginning of July.

b. Strong downrush gusts are common only with thunderstorms moving from the northwest or north.

c. Thunderstorms seem to end abruptly about the 1st of September. Between 1 May and 1 September, they occur about half the days.

d. If altocumulus exists at or near sunrise, thunderstorms will occur in the afternoon.

BUCKLEY ANG BASE (BKF) FORECAST GUIDE

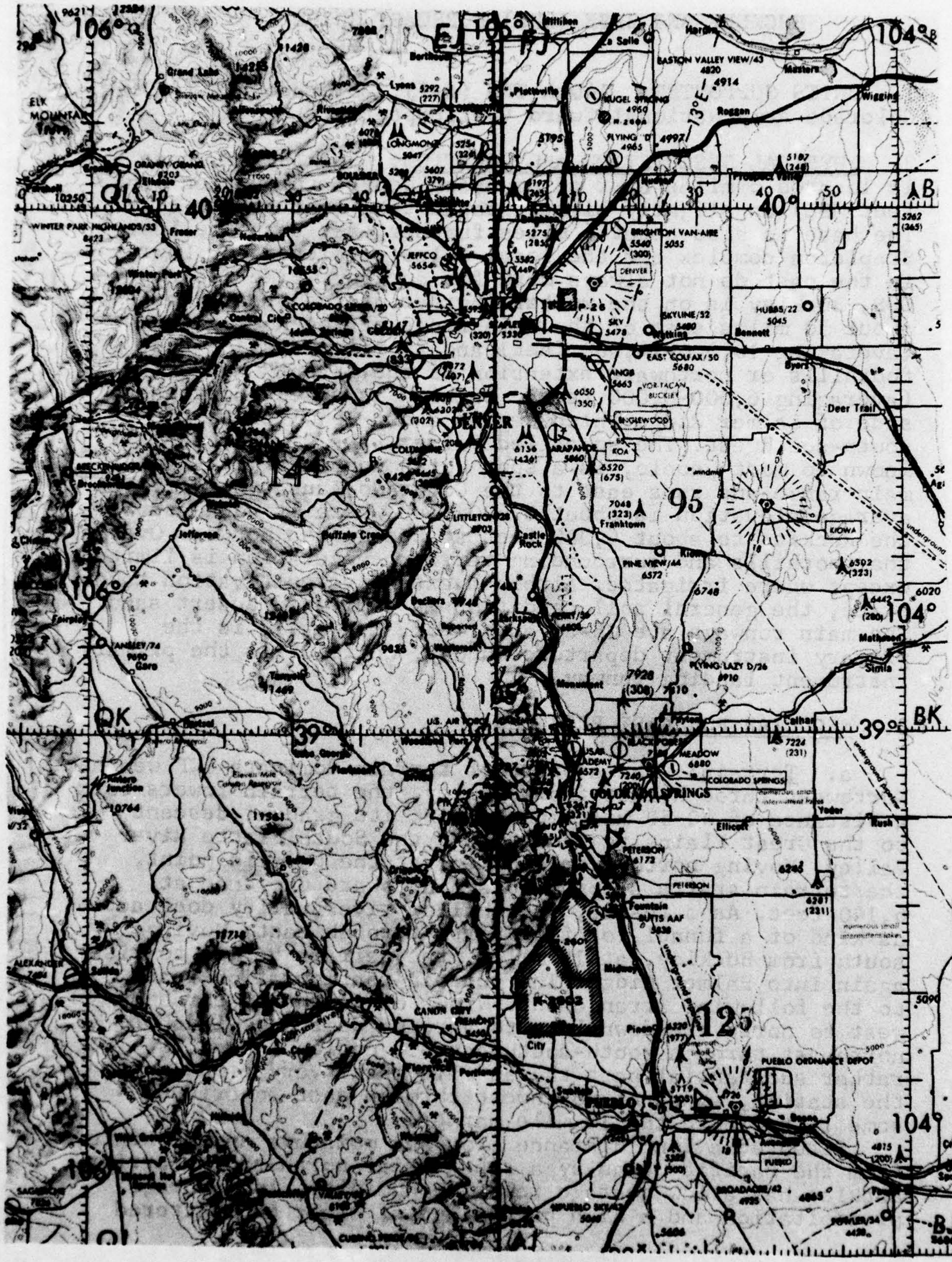
1. UNITS SUPPORTED: 140th TFW (A-7), Colorado ANG (AF), Colorado Army National Guard (Helicopters).

2. PHYSICAL DESCRIPTION AND LOCATION: Buckley ANG base is located 6 miles east of downtown Denver (elevation 5,663 feet MSL) on slightly higher ground than most of the city. The base is also about 6 miles further east than the Lowry-Stapleton complex and the local rules developed for Lowry in the past do not always work for Buckley. Like FCS and COS, Buckley is on the western border of the Great Plains about 50 miles east of the main range of the Rockies (averaging 10,000-14,000 feet) and 25 miles east of the foothills or northward extension of the "Front" Range (averaging 6,000-8,000 feet). Buckley is on the northeast side of Palmer Ridge which begins about 15 miles to the south-southwest. The so-called Palmer Lake Divide, as it is known to most people, is a spur which connects with the main range and runs east to the Colorado-Kansas Border. Its average elevation is about 8,600 feet where it connects at the Rockies to about 4,000 feet at the Kansas Border. Over the foothills and surrounding terrain, vegetation is limited except where irrigated. Although extensive cultivation takes place, the general soil condition is semi-arid desert sand. The main runways are 08-26 and 14-32. Runway 14 is the primary instrument departure runway, while 32 is the primary instrument landing runway.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The aspects of terrain dominate BKF weather. Northwest through east from Buckley, the terrain lowers for a distance of 40-50 miles continuing its gradual descent to the Great Plains region through the South Platte River Valley. Moving north from Buckley, at the 60 mile point, the/terrain starts sloping up again toward Cheyenne at 6,140 feet. As a result, the shallow river valley does act as kind of a funnel for flow north through east. Moving south from Buckley, at 15 miles, the terrain begins to rise again into Palmer Ridge. The terrain configuration leads to the following arrangement. Winds of southeast through west to north are downslope to varying degrees. Winds of northeast through south-southeast are upslope which is rather substantial past the 50 mile mark. Very close in to the station, winds of northwest through east experience some lift within the 10 mile marker.

Situated a long distance from any moisture and separated from the Pacific Ocean by a substantial north-south barrier, Buckley has a low average relative humidity, low average precipitation and a high percentage of clear to scattered


106°
105°
104°
40°
39°
LONGMONT
BOULDER
JEFFCO
BRIGHTON VAN-AIRE
DENVER
SKYLINE/32
HUBBS/22
EAST COLFAX/50
BUCKLEY
ENGLEWOOD
ARAPAHOE
LITTLETON
Castle Rock
Franktown
Kiowa
KIOWA
PINE VIEW/44
FLYING LAZY D/26
Monument
Deer Trail
Byers
Bennett
Wiggins
Roggen
LaSalle
EASTON VALLEY VIEW/43
FLYING "D"
Platteville
Lyons
Berthoud
Grand Lake
Fraser
Jefferson
Fairplay
Buffalo Creek
US AIR FORCE ACADEMY
USAF ACADEMY
COLORADO SPRINGS
PETERSON
Fountain
BUTTS AAF
Ellicott
Calhan
Yoder
Rush
Midway
CANON CITY
PUEBLO
PUEBLO ORDNANCE DEPOT
BROADACRE/42
FOWLER/54
95
125
14
underground

sky conditions. Since there are no bodies of water in the immediate area which affect the Buckley weather, orographic movement of the air is the main significant factor which influences the local weather.

Pronounced Chinook effects occur with northwest, west and southwest wind, with the greater effect and most frequent occurrence being from the west-northwest. Night winds are generally pure drainage winds from a southeasterly through southwesterly direction nearly parallel to the main mountain range. Afternoon winds with weak pressure gradient conditions are pure valley winds from northeast through east-northeast. It has been well established that the "chimney effect" of the heated surface of the foothills accelerates the initial formation of thunderstorms during principle storm season. The eastern and southern faces of the mountains in the Front Range breed thunderstorms which drift out over the heated plains with the speed of the winds near mountain top level and continue to develop.

Cheyenne and Denver, because of their similar locations along the east slope of the Rockies, have similar weather patterns. Denver has more exposure to downslope winds, consequently it experiences fewer low ceilings and less fog than Cheyenne. Since a large portion of Denver's worst weather approaches from the north, Cheyenne is a fair indicator of what is coming.

b. Pollution Sources: The city of Denver has a growing pollution problem. In addition to the industrialized South Platte River Valley, automobiles, trash and home heating plants are the prime pollution sources. Almost all of these sources are concentrated to the west-northwest of Buckley in an area several hundred feet lower than station elevation. The effect of air pollution on the local weather is significant only during the coldest half of each year. During this period, low visibility in the metropolitan Denver area due to smoke or smog occur most frequently after a cold frontal passage which produces a strong low-level inversion. The presence of snow cover increases the severity of the visibility restriction. Even during periods of strong pollution potential over the city, most of the fog/smog is confined to the lowest parts of Denver along the South Platte River. Prevailing winds at night and early morning increase the effects of the pollution to the north of the city by a factor of two. By late afternoon, northeasterly "valley breezes" return the heaviest smog to the center of town and significantly increase the effect south-southwest of the metropolitan area. Only when there is a light northwesterly wind does the pollution really affect the Buckley area. Visibility rarely goes below 2 miles in such cases. However, quadrant visibility to the west-north may reach one mile for short periods.

c. Hazardous weather:

(1) Low Level Turbulence: In addition to turbulence associated with frontal passages and thunderstorms, low level turbulence frequently occurs in the Buckley area due to thermal heating and/or moderate winds. Chinook winds combined with the funnel effect of mountain passes produce moderate-severe low level turbulence over the Rockies and along the foothills. At Buckley, the effect is most pronounced during spring on cool clear days and during summer on days when surface temperatures exceed 90°F.

(2) Mountain Wave Turbulence: (See also COS Forecast Guide). Mountain waves can occur during any time of the year along the Rockies. However, winter and spring are the preferred seasons. Mountain wave forecasts can be made daily from a subjective weighting of the following synoptic features:

(a) Windflow of 25 knots or more from the SW-W-NW over Denver at 10,000 feet.

(b) An increase of wind speed from 10-14,000 feet and from 18-20,000 feet.

(c) Existence of a stable layer at Grand Junction between 800 and 600 mb.

(d) Jet stream at 300 mb over Colorado, Wyoming or Montana at 2000L the previous evening.

(e) Surface high over the Plateau west of the Continental Divide and/or along the Canadian Border through northwest Colorado.

(f) Slight lee-side trough at 700 mb.

(g) Above normal height difference between Albequerque and Great Falls at 700 mb.

d. Seasonal Weather: During the months of June through August, orographic/thermal thunderstorms are practically the only restrictions to ceiling and visibility at Buckley. During most thunderstorms, field conditions rarely go below category D. They occur mostly between 1200L and 2100L, leaving most mornings sunny and excellent for flying. The shading effect of cumulus development usually occurs prior to maximum heating time; therefore Buckley experiences surface temperatures of 90°F or more only 23 days each year. These brief periods of high temperatures normally occur when winds aloft transport desert air from the Southwest over Colorado. In autumn during the months of September through November, downslope or Foehn winds are frequent with generally scattered clouds and good visibility. September has a few thunderstorms of the summer type, cP frontal passages with their upslope stratus and precipation begin in October and November. Generally though, adverse weather during autumn is brief. Icing and turbulence increases in frequency and are paticularly hazardous over mountainous terrain.

More cloudiness and poorer flying weather occur during the winter months of December through March than at any other time of the year. Almost all precipitation is in the form of snow which is exceptionally dry with relatively little moisture content. Invasions of cold air from the north intensified by its depth can be abrupt and severe (Types E, D occasionally). However, many cold air masses moving south over the Plains are too shallow to affect Buckley (Type A). Cold air surges from the west are modified in their descent down the eastern slopes of the Rockies, and chinooks often result from these westerly flow patterns. Synoptic winter weather can affect Buckley as late as May. Upslope circulation with stratus, snow and fog is the primary hazard to aviation. Buckley reaches its peak adverse weather during February, March and April primarily due to various upslope situations (Types C, D and E). Moderate to heavy icing and moderate turbulence is frequently encountered in the local flying area. When not under the influence of one of these types, weather is generally excellent with ceilings above 10,000 feet and unrestricted visibility. In spring, synoptic patterns of winter continue to affect Buckley through May with decreasing intensity and frequency. During the latter part of March, snow occasionally becomes mixed with rain and then becomes mostly rain by the end of May.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

WINTER

a. Type A: As mentioned in the COS Forecast Guide, Alberta Low trailing cold fronts may not affect the slopes stations too much as flow is northwest aloft. This situation, however, does lead to a stationary cold front running north-south through Colorado with a cP high fairly stagnant over the Eastern Plains.

(1) Clouds: If the front oscillates back and forth; west of BKF at night, east of BKF during the day. Diurnal stratus/fog is likely with clear afternoons.

(2) Visibility: Unrestricted except category D in haze and smoke under the stratus layer.

(3) Precipitation: None.

(4) Winds: SW 5-10 afternoon; E-NE 5-10 at night.

b. Type B: Trough aloft embedded in zonal flow. Flow west-northwest over Colorado in the mean as mP front comes through area. Portion of Basin High breaks off associated with temporary jet maximum and moves off into Plains. If the flow aloft is southwest prior to frontal passage, watch out for wave formation in southeast Colorado.

(1) <u>Clouds</u>: Heavy Ac/As in category E may lower briefly in precipitation. If a new low does not form on front, expect system to affect area for about 12 hours.

(2) <u>Visibility</u>: Unrestricted but mountains obscured.

(3) <u>Precipitation</u>: Light snow showers unless wave forms and then expect heavy precipitation (rare).

(4) <u>Winds</u>: S-SW 5-10 increasing, shifting to NW with frontal passage. Moderate turbulence likely.

c. <u>Type C</u>: The Type C affects BKF about the same as COS depending upon frontal location. The case we will discuss here is the situation where the whole trough aloft starts to move eastward bringing out a major system from the Southwest. About 12 hours prior to the wave moving off the Continental Divide and reforming in the lee-side trough, precipitation begins. Strongest development of the low occurs during the 12-hour period prior to passage of the wave through southern Colorado. During this period, a 7 mb DEN-GJT pressure gradient will sustain upslope flow. Movement out of Colorado is slow as stacking becomes more vertical. In 24 more hours, the upper trough passes, and middle cloudiness clears out. Watch for renewed shot of Canadian air as a CA cold front.

(1) <u>Clouds</u>: Upslope stratus may begin 12-18 hours in advance of the low moving off the Continental Divide. Ceiling is likely category B, possibly A at times as precipitation increases. Ceilings are likely to stay below 1,000 feet for 18 more hours until the precipitation stops. Clearing likely as trough passes aloft but may deteriorate again with passage of cP front from north.

(2) <u>Visibility</u>: Unrestricted to category C as snow begins, down to A in heavy snow 6-10 hours during heaviest precipitation. Back up to D in snow showers 12 hours prior to passage of trough aloft. No precipitation expected after that unless a fresh cold front moves into the area.

(3) <u>Precipitation</u>: Begins about 6 hours prior to wave coming off the Divide and reforming. Continues until upper trough passage.

(4) <u>Winds</u>: SE 5-10 becoming NW 15-25; higher gusts as storm moves into Plains. Strong Chinook effect and moderate turbulence likely. Winds may veer back to NE if more cold air pushes into area. Moderate to severe turbulence.

d. <u>Type D</u>: Classical Colorado Low affects BKF in much the same way as COS. Weather elements should also be forecast the same. Period of heavy precipitation and low ceilings is about 1/2 as long as Type C above. In true D, complete clearing is likely 3 hours behind upper trough, and there is little chance of a secondary cP frontal passage of any significance. Strong chinook and moderate turbulence likely.

e. Type E: E types come in all shapes and sizes; most of which affect BKF but not necessarily COS. Common to all Type E patterns is a 1020 mb high in summer and a 1040 mb high in winter. The effect of the front on the immediate area is short and rarely exceeds 6 hours. Ceilings are normally high B or low C at onset, lowering to B with precipitation; remaining C with no precipitation. Many fronts come through after sunset.

Fast Moving

(1) Clouds: Rapid deterioration to B 1-2 hours after frontal passage. Will stay in until mountain top winds reach 25 knots from the northwest. Rapid improvement is likely within 4-6 hours of onset of southeast surface wind.

(2) Visibility: Unrestricted; lowers to B in snow and A if snow is riding on 25 knot winds.

(3) Precipitation: 2-6 hours of snow rarely exceeds 3 inches.

(4) Winds: 25 knots out of N-NE, possibly higher gusts rarely exceed 6 hours.

Slow Moving

(1) Clouds: Same ceiling but deterioration is slower and apt to be lower. Duration 12 hours.

(2) Visibility: Same with precipitation but category A very unlikely.

(3) Precipitation: Same as above.

(4) Winds: NE 10-15 will shift to SE in 12 hours.

SUMMER - See Colorado Springs (Peterson Field) Forecast Guide.

5. SEASONAL FORECAST RULES:

WINTER

a. With a significant surface system if the 700 mb flow is southwest, forecast moderate precipitation. If flow is northwest, expect none to light precipitation. (Exception; arctic outbreaks).

b. When BKF is under a combined upslope-overrunning condition, the probability of low ceilings is ordinarily in direct proportion to the occurrence of precipitation of at least one hour in duration. When rain or snow occur, the ceiling is almost certain to fall below 1,000 feet and likely to fall below 500 feet until the upslope flow gives way to a northwesterly surface wind. (Exception: arctic outbreaks, southeasterly surface wind).

c. Low ceiling and visibility occur frequently and tends to persist when a cold front hangs in 50 to 100 miles south of BKF. The "front" is defined on the cold side by at least three closely-packed 1000-500 mb north-south thickness lines with low-level winds directed into the front.

d. Dissipation of the above conditions should be forecast when the thickness lines tend to become perpendicular to the front, and/or the low-level winds begin to parallel the front.

e. True radiation fog is rare because of the sloping nature of the surrounding terrain. Nevertheless, nocturnal radiation with southeast winds can be a strong factor in producing upslope fog but never the primary factor. Upslope and/or advected stratus is much more common.

OFFUTT AFB (OFF) FORECAST GUIDE

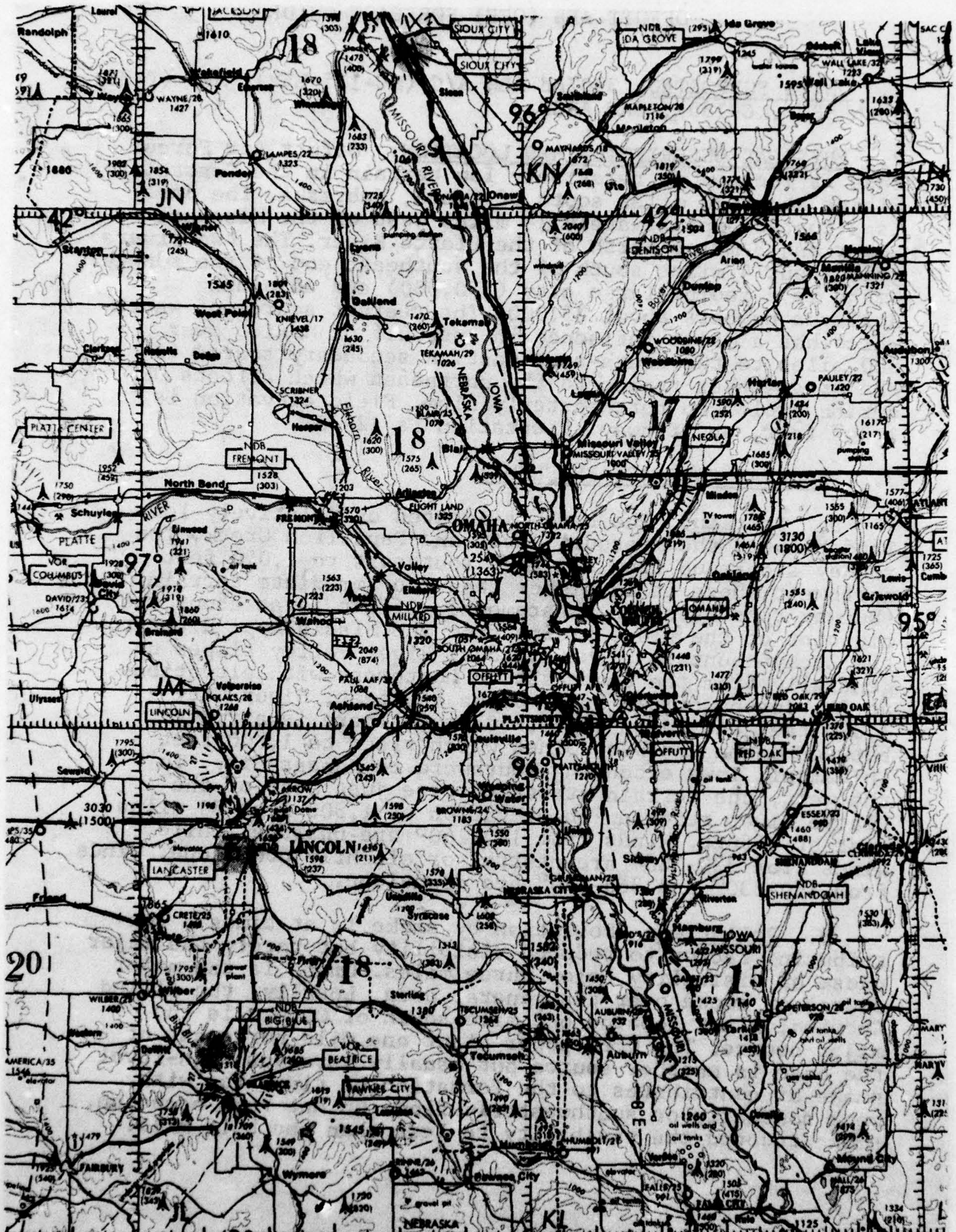
1. UNITS SUPPORTED: 3902nd ABW A/C (KC-135 LSM), MAS (T-39), 55th SRW (KC-135), SAC ABCP.

2. PHYSICAL DESCRIPTION AND LOCATION: Offutt Air Force Base is located on relatively low terrain in the Central Plains about 10 miles south of Omaha, Nebraska. The base is situated approximately 1½ miles west of the Missouri River and 3 miles north of the Platte River. The two rivers join about 4 miles south of the southeast end of the runway. Omaha is a medium large city (350,000) and adjoining Bellevue numbers about 25,000. The nearest source of water which has a major influence in the Gulf of Mexico over 800 miles to the south-southeast. A secondary source is the Great Lakes region to the northeast which affects OFF during prolonged northeasterly flow. Field elevation is 1,047 feet, and runway orientation is 12-30.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The base is located on relatively low land between the Missouri River and Papillion Creek. The runway slopes up from 970 feet southeast to 1,050 feet northwest where it is higher than the immediate terrain. (Runway runs along an escarpment). Offutt is at about the midpoint of the slope rising from the Mississippi River to the Rocky Mountains. The Missouri River Valley slopes up generally from the southeast to northwest with elevations at St. Joseph of 825 feet, Omaha 950 feet, Sioux City 1,080 feet and Huron ,SD 1,250 feet. There is a ridge between Omaha and Des Moines which rises to 1,000 feet in Lamoni, Iowa extending southward to Kansas City. To the west, the terrain starts to rise just west of the Platte River reaching an elevation of 1,800 feet 80 miles west of Offutt. Winds from 120-160° are upslope, while winds from 330-360° are neutral or slightly downslope. Winds from 160-330° and 360-120° are downslope.

b. Pollution: Pollution by smoke is at times a contributing factor to reduced visibility but rarely the major cause of visibility below three miles. Omaha is the major source of smoke over the general area. Locally, the Allied Chemical Plant located one mile south of Offutt is the major source. The OPPD power plant one mile northeast of the base is another source but usually involves high-level smoke or contributes to the formation of river fog with weak southerly or southwesterly flow. On one rare occasion, smoke reduced the visibility to less than one half mile.


SIOUX CITY
IDA GROVE
DENISON
PLATTE CENTER
FREMONT
COLUMBUS
NEOLA
OMAHA
MILLARD
OFFUTT
LINCOLN
RED OAK
LANCASTER
SHENANDOAH
BIG BLUE
BEATRICE
MISSOURI
RIVER
NEBRASKA
IOWA
North Bend
Schuyler
PLATTE
Wahoo
Valley
Ashland
Louisville
Wilber
Auburn
Tecumseh
Wymore
FAIRBURY
Missouri Valley
Woodbine
Harlan
Hamburg
Riverton
Shenandoah
Nebraska City
Syracuse
Tekamah
Blair
Oakland
Lyons
Pender
West Point
Randolph
Wayne
Wakefield
Stanton
Crete
Seward
Valparaiso
Dunlap
Manning
Audubon
Mapleton
Onawa
Sloan
Ida Grove
Wall Lake
Elkhorn
PLATTSMOUTH
SOUTH OMAHA
NORTH OMAHA
COUNCIL BLUFFS
42°
41°
96°
97°
95°
18
17
20
15
3030
(1500)
3130
(1800)

This was over a snow cover with a strong surface inversion, surface temperature near zero and calm surface winds. Smoke collected in the low areas after sunset and reduced visibility to 1/16th mile between 2300-0100L. By 0200L the visibility was above one mile, and no further decrease in visibility was noted.

c. Seasonal Weather: Polar and arctic air masses dominate Nebraska during winter. Flying weather deteriorates in low clouds, snow and fog as cyclonic storms and cold frontal weather move through the area, normally alternating with generally fair cold highs. Approximately 25% of the winter ceilings and visibility fall below 3,000 and 3 with 12% below 1,000 and 2. Cold fronts move south or southeast with the cold air boundary while remaining nearly stationary from the Nebraska Panhandle northwest into Idaho. The cold front usually brings a narrow east-west band of clouds with strong north or northwest winds and good visibility except in occasional snow showers (Type E; sometimes Type A).

Low systems which bring the worst weather are of two types. The first develops in the southern Rockies and moves east (Type C). The second, and often the more severe, develops and tracks east from Colorado (Type D). Fast-moving storms and those which move north of Offutt normally do not cause very poor weather (A, B, E), while slower moving systems passing to the south can produce freezing precipitation and heavy snows as Gulf moisture becomes available. The severity of both storms is highly dependent upon the location of the high pressure cell over the southeast U.S. which allows advection of moisture-laden air from the Gulf up the Missouri River Valley. The associated upper level trough contributes to the storm's intensity when it digs southward and moves slowly eastward toward the developing surface low and with moisture present develops a thick nimbostratus with heavy snowfalls just east of the trough.

Occasionally the Nebraska area will experience snow under a continental high either from low level stratocumulus or from westerly flow overrunning the cold dome (Type C). In the latter, cloud bases are usually above 3,000 feet. Stratocumulus with bases of one to 3,000 feet often form in the northwest flow behind cold fronts when winds in excess of 20 knots create sufficient turbulent mixing (Type A,E). The stratocumulus also tends to form 1-3 hours after sunrise and dissipates shortly after sunset. (This does not happen with mP air except during summer). Most likely heating or its cessation affects the stability of the boundary layer and hence mixing.

Winter fogs are usually of a radiation type, forming in the early morning near sunrise in the calm or light southeast flow off a high which has just moved east of Offutt. These fogs, being local in extent or confined to the river areas, normally last only a few hours after sunrise

Less frequent but more widespread and persistent fogs develop when a stationary north-south oriented front to the west combined with a ridge over the Great Lakes traps saturated southerly flow. After initial cooling and formation, the heavy fog and stratus may last for a week or more and usually requires the front to pass to the east of the station to relieve the situation.

In the spring transition period, the mean position of the polar front begins to move northward yielding more frequently to the tropical Gulf air. As the season progresses, mP air begins to cross the Rockies, mixing to the surface and replacing the drier continental air. Cyclonic storms are still significant with flying weather improving steadily. Early spring's visibility and ceilings are not as poor as winter values decreasing to 6% below D category and 4% below C category for April and May respectively.

As warmer Gulf air becomes available, rain and freezing precipitation increase and often are mixed with snow. The warmer air also lowers stability values, and thunderstorms increase from one day in March to four in April and eight in May. These storms, which may be frontal or overrunning, contribute to higher precipitation totals for spring and summer.

Fog is not widespread during this season, although it may form in moist air that has had restricted heating the day before. Clear skies and light gradients aid this fog situation and are not uncommon. A low stratus may form in light southerly flow where cooling is not sufficient and winds are too strong for fog. Late night and early morning fogs may follow precipitation as well, especially if the winds go to calm after a system passage.

The summer months are dominated by mT air from the Gulf of Mexico. This air is displaced two or three times a month by mP air which has moved across the Rockies and then eastward behind a weak cold front. At irregular intervals, cP air pushes south into the area, but as a rule it quickly retreats northward. The only prolonged periods of IFR weather occur with lows which form to the southwest along an east-west stationary polar front. As the low moves into the Oklahoma - Kansas area, low stratus ceilings, reduced visibility, pre-warm frontal fog and light continuous precipitation will persist as the low moves from the Oklahoma Panhandle to eastern Missouri.

Thunderstorms reach a peak frequency of 10 days per month in June and bring perhaps the most hazardous weather of any season. Almost all thunderstorms are frontal with air mass storms being rare. Thunderstorms caused by overrunning usually display little organization and often develop over large areas in less than an hour, lasting for periods of six hours or more. In contrast, cold front or squall-line storms can usually be tracked by radar at a distance as they develop to the west. These storms tend

to intensify just east of Offutt where moisture values increase in the southerly flow from the Gulf.

Summer synoptic patterns continue over Nebraska during September and an early part of October with mT air masses receding slowly southward. During October, relatively dry and stable mP highs move into Nebraska following weak troughs with excellent flying weather continuing for several days. The first significant incursions of cP air occur in November with frontal structures becoming more defined and assuming more regularity of movement. The main cause of unfavorable flying weather in the fall is low pressure systems passing to the south of the station. Occurrences of rain are most prevalent with rain changing to snow or rain and snow mixed especially during the latter part of the season. Another cause of poor flying weather is radiation fog which becomes more frequent in October and November. A typical case of radiation fog occurs as the return circulation around a high brings light southeast winds up the Missouri River Valley. Another case is a weakening maritime front moving in from the northwest with a substantial rain pattern. The front either rides aloft over Offutt or washes out in the local area. Both situations are preceded by restricted daylight heating, increasing dewpoints and very light winds after sunset. Precipitation may or may not precede the fog formation, but clearing at sunset is normal before fog formation.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

WINTER

a. Type A: Alberta Low trailing cold front likely to pass OFF; cP outbreak generally weak with frontolysis south of OFF.

(1) Clouds: Category C or low D stratocumulus for a brief period behind the front; scatters by sunset. Reformation of clouds later due to overrunning is unlikely.

(2) Visibility: Unrestricted.

(3) Precipitation: Isolated snow showers.

(4) Winds: SW 10-15 shifting to NW 15-25 then tapering off rapidly.

b. Type B: Assumes that no wave forms on trailing mP front down in the Texas Panhandle or in southern Kansas (which one should always be alert for). Portions of the Great Basin High follow front into the Plains (fronts usually go through at night).

(1) Clouds: A fast moving front will not draw up sufficient moisture into the low circulation, whereas a

slow-moving one may. The latter will have category C ahead of the front with middle clouds above. The extent of the middle cloud depends on how much moisture gets over the Rockies. Category D ceilings due to middle cloud alone are unlikely with a fast moving Type B. Post-frontal clouds are likely especially in late fall and early spring from 1-3 hours after sunrise through the day - most likely in category D.

(2) Visibility: Unrestricted except for light precipitation and/or haze as pre-frontal stratus arrives from the Gulf.

(3) Precipitation: In winter, light snow accumulating about one inch or less may be preceded by a short period of drizzle or freezing drizzle. The amount of precipitation is totally related to the Gulf moisture return.

(4) Winds: S-SE 10 increasing to 20 shifting to WNW 15-25. Slower moving systems will have 5-10 knots less.

c. Type C: Again, this assumes that a wave does not slide out of the Rockies along the cP front or that the whole trough does not come out of the Southwest. If it does, treat like Type D. The location of the southwest-northeast oriented front is totally dependent on the strength of the ridging in southern Canada. One can normally expect the front to lie between OFF and SZL.

(1) Clouds: Category C is probably the best condition that can be expected, and if there is any precipitation at all, conditions will go down to low B and possibly A. Weak troughs aloft give the clue to deteriorating conditions. Movement of the front north of OFF will rapidly improve ceilings to E.

(2) Visibility: Category D in haze and much lower to low B if precipitation begins. Unrestricted if front is north of Offutt.

(3) Precipitation: Light snow or freezing drizzle at times. Thunderstorms have been known to occur.

(4) Winds: NE 5-10. S 15-25 if front is north of OFF.

d. Type D: The track of a classical Type D generally goes right over or just south of OFF, although the track can vary from southern Missouri to northeast Nebraska. The Type D is an mP wave and will be followed by a cP outbreak which is evident in the dewpoint and wind field. A band of clouds usually accompanies this "secondary".

(1) Increasing category E quickly lowers to C as snow or rain begin. Warm-frontal type weather is experienced until the occlusion aloft (inverted trough on the surface) passes. Ceilings become category B 6 hours prior to arrival of trough and remain that way until precipitation stops.

If the temperature is above freezing and the snow is melting, keep the B category in. When the cold air arrives, ceilings will briefly go back down to C before clearing up for good. If the wave passes north, the warm front or occlusion will pass with ceiling immediately going to E. Deterioration to C 12 hours later is possible as cold air works its way around the surface low located in North Dakota or western Minnesota.

(2) Visibility: Unrestricted goes to B or C with beginning of steady precipitation and lowers further if winds cause blowing snow. Visibility is aligned fairly well with ceiling categories. With secondary cold front, no restriction to visibility will occur except locally in snow shower activity.

(3) Precipitation: Depends on track of low. If the temperature is above 45°F when precipitation starts, it will stay rain until the inverted surface trough passes. If the wave moves north of the station, it will rain throughout. As soon as a temperature of 38°F is reached with the 850 mb level below freezing, snow is likely. A study of the past 30 years of snowstorms reveals that if the precipitation starts during late night or early morning that the chances of increased snow/rain are greatly magnified. Precipitation beginning in the late morning or early afternoon rarely results in heavy snow. In the early winter, prolonged moisture advection off the Great Lakes may prolong snow shower activity.

(4) Winds: Wave north; ESE 10-15 shifting to SW 15-25 higher gusts gradually veering to NW and tapering off as wave moves into Dakotas or Minnesota. Wave south; ESE 10-25 becoming NE 15-25, higher gusts and gradually backing but staying strong until the wave is well into the Great Lakes.

e. Type E: Massive arctic outbreak with high cell likely to pass right over OFF or just to north. Cold air may be merely reinforcing previous outbreak.

(1) Clouds: Post-frontal stratocumulus in category C may develop behind front and may go briefly down below 1,000 feet in snow showers. Category E again in 6-8 hours. (Sometimes front will be completely dry).

(2) Visibility: Unrestricted except in intermittent snow showers.

(3) Precipitation: One inch of snow or less. Jet streaks have accompanied such outbreaks and with a strong vertical motion field, as much as six inches in as many hours are possible.

(4) Winds: ESE 5-10 increasing to 20-30 shifting to NW-N 25-35, sometimes higher.

5. **SEASONAL FORECAST RULES:**

a. Summer: In the absence of a mixing mechanism such as morning thunderstorms or frontal passage, afternoon surface winds at Offutt may be forecast by modifying the 900 mb winds on the 1200Z sounding, changing the direction 30° in the direction indicated by the sounding. The surface wind velocity will be .8 of the 900 mb wind unless that wind is 20 knots, then take .5 times 900 mb velocity. If gusts are expected, add 12 knots to the forecast wind for peak gusts.

b. Winter: To assist in forecasting river fog, the temperature of the river can be obtained from the Bellevue Bridge attendent (291-1913). If there is little or no snow cover and the minimum temperature is forecast to be equal or greater than 30° cooler than the river temperature, then forecast below minimums for 2-3 hours near sunrise.

c. Post-cold front stratus: If the gradient wind is 320-030° at greater than or equal to 25 knots and the temperature-dewpoint spread is less than 12°F, then the cloud bases will equal the $T-T_d$ times 200 feet.

d. Diurnal gusty winds: Based upon the 1200Z OMA raob when the inversion breaks, sustained winds will be 80% of the 2,000 foot level speed and direction back 30°. The direction forecast using this method is usually good but the speed forecast is usually 50-100% too high when the wind is from the southwest.

e. Pressure gradient winds: Two examples of figuring the wind speed using the surface pressure gradient:

$$\frac{1 \text{ mb}}{100 \text{ NM}} = 7 \text{ knots} \qquad \frac{3 \text{ mb}}{100 \text{ NM}} = 21 \text{ knots}$$

FORT RILEY - MARSHALL AAF (FRI) FORECAST GUIDE

1. UNITS SUPPORTED: Hq 1st Infantry Div:(UH-1, AH-1G, OH-58, T-41, T-42, U-8, U-21). OL AC 702nd TASS (O-2). Additional amendment criteria of 300 feet and/or 1 mile.

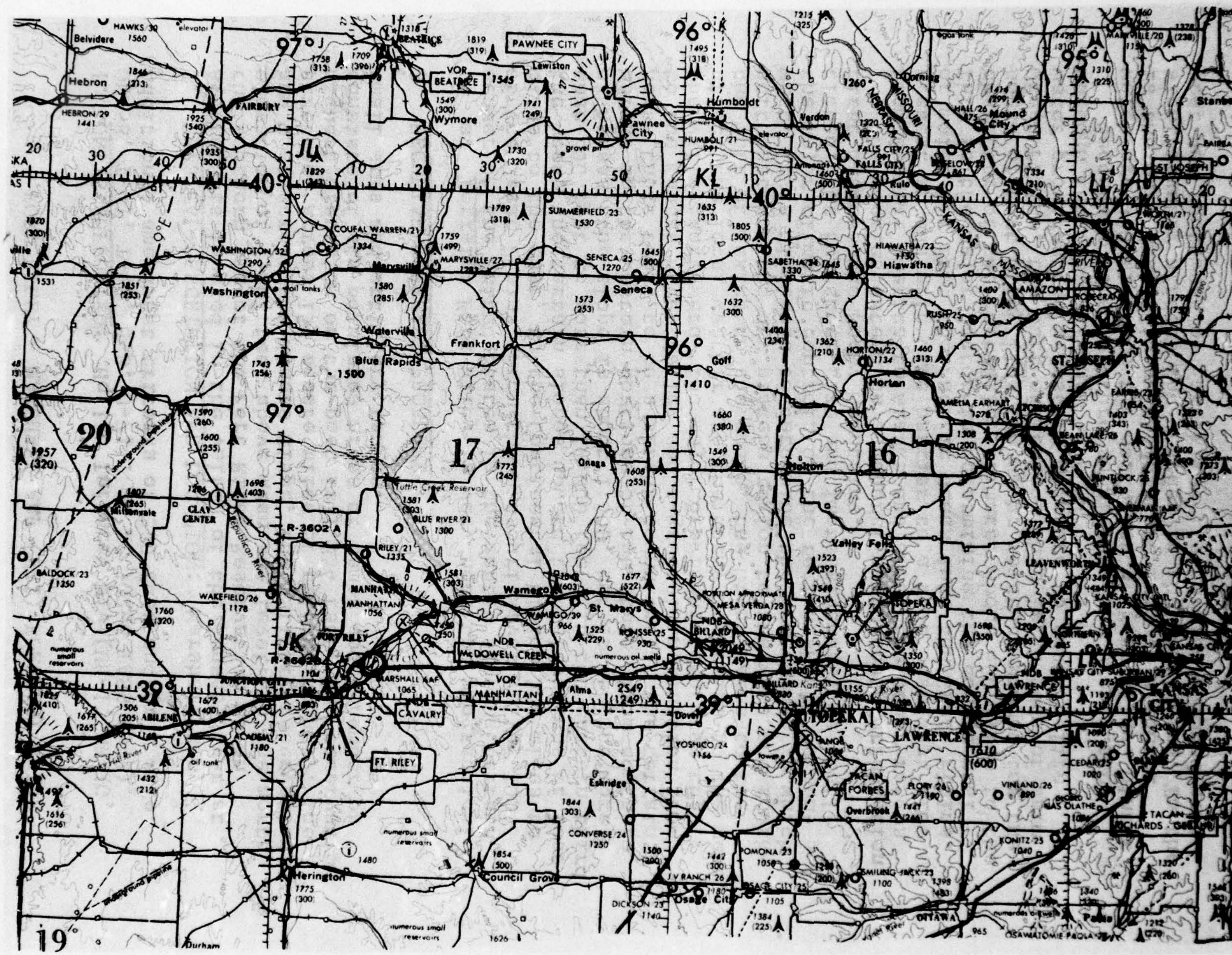
2. PHYSICAL DESCRIPTION AND LOCATION: Marshall Army Airfield is located in the valley of the Kansas River at the southern tip of the Fort Riley Reservation at an elevation of 1,062 feet above mean sea level. To the north and west across the Kansas River, the military reservation stretches across 158 square miles of rolling country. The highest elevation on the post is 1,354 feet. The reservation consists of six populated areas or camps and a number of small arms and artillery ranges.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Fort Riley is very near the geographical center of the United States in the gently sloping terrain of the Great Plains. From the Missouri River Valley 100 miles to the east, to the Continental Divide 500 miles to the west, the terrain slopes upward from elevations of less than 800 feet to more than 14,000 feet. In the eastern third of Kansas, the slope is about 1:500, but it becomes more abrupt in the western portions of the state. From south to north there tends to be a slight downslope of the terrain to the Kansas River Valley and a gradual inclination from the valley northward. The major orographic features that affect the local weather are the Rocky Mountains to the west, the Gulf of Mexico to the south, the Great Lakes to the northeast and the dry plateau region to the west and southwest. It is difficult to determine the precedence in which the major climatic controls of the region should be mentioned, but for sheer size and impressiveness, we shall first discuss the Rocky Mountains.

The Rockies extend on a general north-south orientation from Central America to Alaska and among the other ranges present an 800 mile wide barrier to a free east-west flow of moist air from the Pacific Ocean into the Great Plains. This is the major factor in determining the continental character of the Fort Riley climate. About 650 miles to the south of Fort Riley lies the major moisture source for the Great Plains, the Gulf of Mexico. This large body of warm water provides the necessary moisture to sustain life through the Great Plains.

Secondary as a moisture supply are the Great Lakes which are 450 miles to the northeast of Fort Riley. Winter is the only season in which moisture from this source significantly affects the weather in the local area. To the west and southwest of Fort Riley lies a wind-whipped area


Belvidere
Hebron
FAIRBURY
PAWNEE CITY
Lawiston
Wymore
Pawnee City
Humboldt
Verdon
Dawson
Washington
Marysville
Seneca
Hiawatha
Frankfort
Blue Rapids
Waterville
Goff
Horton
Holton
Onaga
CLAY CENTER
Tuttle Creek Reservoir
Valley Falls
TOPEKA
LEAVENWORTH
Wamego
St. Marys
McDOWELL CREEK
MANHATTAN
CAVALRY
FT. RILEY
Alma
ABILENE
TOPEKA
LAWRENCE
Eskridge
Herington
Council Grove
Osage City
OTTAWA
FORBES
Overbrook
AMAZON
ST. JOSEPH
KANSAS CITY
Durham

known as the "Panhandle". The area during dry years provides a significant amount of dust. Since there are no large cities or industrial areas near Fort Riley, there is little or no air pollution. For the local area, winds of southwest through northwest are downslope, while winds from northeast through southeast are upslope. With a due north or south wind, the terrain is essentially neutral. Also with wind northwest through northeast, the effects will be somewhat blocked due to the hills to the north. From this discussion, it can be seen that the major feature in the extremes of weather at Fort Riley is that the air from both north and south is generally free to move back in the local area with little effect from terrain. This accounts for the cold arctic outbreaks that move down from the north in winter and the warm moist flow from the Gulf in the summer that supplies the moisture for thunderstorm activity that dominates the weather in what is commonly known as "Tornado Alley".

b. Seasonal weather: This area possesses a pronounced four-season climate. The winter season in this area includes the months December through March. It is a season of frequent marked changes and provides some of the most severe weather. The severity of winter weather is contolled by the type of air mass constituting the high pressure area which either dominates or is about to dominate the Great Plains. The local area receives its most prolonged periods of good weather from the comparitively warm Great Basin High which extends at times out over the Plains (Type B).

One of the most common patterns of winter weather is a low cell moving southeastward along the eastern edge of the Pacific High (Type D). The degree of southeastward movement can sometimes be determined by the flow at the 700 and 500 mb levels, although in other cases the low develops and begins to move southward before it is indicated aloft. In some cases when warm ridging is of sufficient strength to leave a high in the Great Basin, the low will move eastward across the Dakotas or Nebraska, beginning its southward movement well to the east of the local area. In such cases, precipitation is closely associated with the frontal passage or with the layer of stratocumulus clouds that frequently follow 4-6 hours after the surface front passes. The condition is temporary lasting 8-12 hours; then clearing occurs followed by a period of good weather. The amount of precipitation will vary with the amount of moisture present, which in turn depends upon the flow from the south or southeast (moisture from the Gulf) that has occurred prior to the frontal passage. Clearing may be anticipated by the tendency of the winds to back from the north to the west thereby indicating that the ridge is moving south and west of Fort Riley.

The second pattern of winter weather is that of cA air moving south from Canada (Type E). This is aided by the weakening of the warm high in the Pacific and the breaking

down of the high in the Great Plains. This arctic outbreak may be anticipated by sharp cold advection in the upper levels and a sharp intensification of the upper trough in the Gulf of Alaska. This is accompanied by the surface front moving into Washington with rapidly falling pressures in British Columbia and large pressure rises in central Canada. In early spring or late winter, the upper air flow becomes generally southwesterly. When this occurs, cyclogenesis usually occurs in southeastern Colorado (Type D again) or Texas (Type E). As these lows move through Oklahoma (or Kansas), clouds and precipitation form to the north of the low causing heavy precipitation in Kansas. In the spring months, April-June, the paths of cyclones shift northward, and cold fronts (without the lows) pass more frequently. Preceding each front, strong southerly winds bring moisture into the region from the Gulf of Mexico. This creates conditions favorable for the formation of thunderstorms along or ahead of the cold fronts. Squall-lines have a tendency to form to the east of the local area in early spring, but by the latter part of May they usually form to the west of Fort Riley with some intensification as they move eastward.

The summer season may be loosely defined as the period from the last half of June through the first half of September. During most of this time, the semi-permanent high pressure system over the southeastern United States causes a continuous flow of warm moist mT air from the Gulf of Mexico into the Southern Plains. Winds aloft across the continent tend to be zonal with few southward pushes of cold air. The polar front assumes an east-northeast to west-southwest stationary orientation across northern Kansas in the beginning of the season. It gradually drifts northward until at the height of the summer season, its mean position in near 50 degrees north. In June and early July, the stationary front oscillates through an area extending about 150 miles north of Fort Riley, but the north-south movement of the front rarely exceeds 10 knots. Frontal passages are almost non-existent at Fort Riley during late July and August. Hot and humid weather prevails for most of the period with a tendency toward hot dry weather in late August. The latter is associated with a further westward building of the Bermuda High and a resulting more over-land trajectory of the mT air. The same tendency persists through early September. The polar front again begins to move southward in mid-September bringing frontal activity and cooler weather to the Fort Riley area. The most significant weather element during the summer months continues to be the thunderstorms with a sharp tendency toward nocturnal activity. Fog and stratus, widespread layers of cloudiness or gradient wind gusts are seldom observed at Fort Riley during the summer.

The period from the last half of September through November is primarily a transition period between summer and winter weather patterns. The average storm track in this

period reflects the gradual southward displacement of these normal winter paths through the Central States. The predominant type of front affecting the local area during the early part of this fall period is the mP front moving in from the west-northwest. (As indicated earlier, the low centers pass considerably to the north of this area with only the southern parts of the mP fronts passing Fort Riley). Although the surface frontal characteristics of this type are frequently weak, it is very possible to have a strong cold trough aloft. As it approaches from the west, squall-lines usually form in advance of the surface front. cP fronts from the north become more frequent as the season progresses, and by the end of the season they are the predominant type.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the GVW and SZL Forecast Guides.

5. SEASONAL FORECAST RULES: None.

AD-A035 651 AIR FORCE GLOBAL WEATHER CENTRAL OFFUTT AFB NEBR F/G 4/2
FORECAST GUIDES USED FOR THE CENTRALIZED TERMINAL FORECAST PROG--ETC(U)
DEC 76 A T SAFFORD

UNCLASSIFIED AFGWC-TM-76-2 NL

3 OF 6
AD
A035651

RICHARDS - GEBAUR AFB (GVW) FORECAST GUIDE

1. UNITS SUPPORTED: Hq AFCS, 1866th Facility Checking Sq, 442nd TAW (AFRES).

2. PHYSICAL DESCRIPTION AND LOCATION: Richards-Gebaur Air Force Base is located on a ridge approximately 20 miles south of the confluence of the Missouri and Kansas Rivers. The base is located near the top of the ridge with the highest point (1,125 feet) one mile south of the airfield. To the west, the ridge slopes to the Blue River between GVW and Olathe. To the north, the ridge lowers until it reaches the Missouri River. On the eastern side, the ridge slopes to the Little Blue River. As the base is higher than the surrounding area, the ceilings move over at a lower height than is generally observed by other stations in the area. At the present time, there are no serious air pollution problems at GVW. The only pollution-producing areas to affect the base are the industrialized sections of Kansas City approximately 20 miles to the northwest through the northeast. During the late autumn when a strong inversion is present in the early morning and there is a light northerly wind, the visibility can drop to 3-5 miles in haze at sunrise, but it quickly improves as the inversion breaks. A small pond on the southeast side of the runway will cause the visibility to be significantly lower to the south than anywhere else on base during periods of radiation fog.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Richards-Gebaur is on the Central Plains of North America which have the characteristics of a slanted table top. On a north-south orientation, there is very little change in elevation from central Texas to the interior of Canada. This general smoothness of the terrain with no east-west mountains allows air masses to move freely into the area either from the arctic or tropics. On a west-east orientation, there is a gentle slope upward from the Mississippi to the Rocky Mountains (400 feet at St. Louis to 6,000 feet at Colorado Springs). With an east-northeast to east-southeast wind, the slope is great enough to cause upslope stratus and fog to form in Colorado and western Kansas but rarely if ever will this alone be enough to cause clouds to form in the GVW area. The Rocky Mountains do act as a barrier to air masses on both the east and west slopes. It will hold both arctic air masses and tropical air in the Plains and will keep them from spreading westward. It also will rob the Pacific fronts of their low-level moisture before they arrive in the Plains. There are no large bodies of water close to the GVW area, and the closest is Lake

FALLS CITY
ST JOSEPH
Pattonsburg
ML
LL
Gallatin
LAKE VIKING
HIAWATHA/22
Hiawatha
SABETHA
CHILLICOTHE
AMAZON
Cameron
NEWMAN FULTON
HORTON/22
Horton
AMELIA EARHART
16
Holton
MACS/25
KANSAS CITY
LEAVITT/24
12
Carrollton
Richmond
MISSOURI RIVER
Lexington
LAWRENCE
VINLAND/26
EAST KANSAS CITY
LAKE WINNEBAGO
SKYHAVEN/20
KONITZ/25
POMONA/23
WHITEMAN
FERGUSON
15
13
CLINTON/20
ANDERSON/24
BUTLER/26
CALHOUN
GOLDEN
Burlington
BUTLER
Appleton City
Rich Hill
MIDWAY
FORT SCOTT
NEVADA
EL DORADO

Michigan 400 miles northeast. The Gulf of Mexico, 650 miles south, is the prime source of moisture and as mentioned above, the terrain to the south is generally flat. If the winds are southerly, the tropical air masses will come northward unimpeded. There are several rivers in the GVW area, but they do not contribute enough moisture to affect the mesoscale situation.

b. <u>Seasonal Controls:</u> Winter (December through February): This is the season when a great variety of weather can be expected at GVW. Often changes are fast and sharp during the season, but as a general rule, weather conditions persist and last longer than any other season. Placed against the average, the base is usually affected by cyclones with their associated fronts every 3-4 days. With these systems, several considerations must be determined for accurate weather prediction.

As pointed out earlier, Canadian cold air masses move southward very fast during the winter, and there are no physical features to deter their movement. Timing frontal passages is important, and fortunately there are a number of reporting stations which enable the forecaster to extrapolate movement accurately. The forecaster must be cognizant of possible cloud and weather modification as these systems move through. Of utmost importance with fronts that influence the base in winter is frontal wave development since waves usually generate inclement weather.

Perhaps the most important winter weather controller is the closed low and its associated front that develops in the Southwest (Types C or D). A few of these low pressure centers will move northeast and pass the station to the north, others will move right through the area, and still others will move east-southeast following the Gulf Coast and give only minor weather to GVW. When systems move to the south of GVW through Missouri or Arkansas (Type E), heavy precipitation and all types of inclement weather are likely. Gulf moisture can cause great synoptic changes to the base weather situation. Low stratus will move rapidly from the Texas area and spread into Missouri and Kansas within 24 hours. Here again, the large number of reporting stations south of GVW make this moisture relatively easy to follow and time.

The controller of high winds in the winter is the surface pressure gradient. Experience shows that winds at GVW are usually 3-7 knots less than those recorded at surrounding stations. A rule that has been used with success for maximum gusts at GVW is to take .8 times the gradient wind for the maximum afternoon gusts.

Good cases of fog and very low stratus encumber operations at the base. One fog control is it's actual location. It is higher than the river beds north of the base, and so upslope plays an important part in the formation of winter fog. The

forecaster should generally forecast fog only with a northerly wind component. Thunderstorms occur very seldom during the winter. However, be aware of thier possibility and not rule out the fact that some can be severe.

Spring (March through May): April and May are the major spring months, but the later part of March and the first part of June often show weather patterns typical of spring. The major weather problem of this season is thunderstorms and the associated hazards. The spring transition between winter and summer provides unstable atmospheric conditions. The lower atmosphere generally heats more rapidly than the air above causing instability and lifting. Coupled with this is the availability of abundant moisture and the presence of fronts. These conditions all favor severe weather (thunderstorms, damaging winds, hail and tornadoes). Thunderstorms during the spring usually form in lines as opposed to the isolated air mass thunderstorms of summer. Stratocumulus ceilings are prevalent during spring with occurrences of lower stratus ceilings decreasing as the season progresses. Winds tend to stay predominantly from the south. Care must be exercised in forecasting low ceilings for long periods in spring. Changes occur very rapidly, and long periods of low overcast skies with poor visibility decrease markedly as the season progresses and of course because of increasing instability in the mean. Storm tracks during the season pass just north of GVW. Post-frontal clouds are not as lasting, nor are ceilings as low as in winter. However, cyclones occasionally pass south of the base with heavy rain, overrunning thunderstorms, low ceilings and visibility resulting.

Summer (June through August): June can have the characteristics of both spring or summer. Thunderstorms of spring intensity often occur in June. However, as the season progresses, storm tracks stay well north of GVW. The Bermuda High migrates slightly west, and hot oppressive temperatures with high humidity cover the region. Occasional frontal passages occur, but their influence is only slight. Flying conditions are usually excellent with cumulus clouds scattered throughout the area. Thunderstorms often occur in summer. Stability and weak fronts with minor upper air perturbations are the principle controlling factors. Severe weather is a constant possibility during this season. Most thunderstorms are of the air mass type and often occur at night. Fog or haze occurs occasionally in the morning hours. Most of this time, the haze will burn off within an hour or so, and good visibility may be forecast with confidence. With frontal passage in the summer, squall-lines often occur ahead of the fronts. While these lines are not as severe as a rule as those of spring, constant attention must be paid to them. Look for contrasting levels of moisture, an unusually sharp temperature gradient and abundant low-level moisture. High winds and hail are the usual severe occurrences with these storms, but tornadoes can not be ruled out entirely. Also be alert to fronts becoming stationary

south of GVW. Overrunning usually occurs causing rain, thunderstorms and ceilings.

Autumn (September through November): Autumn is the transition period between hot and cold weather. It can show its presence in September through November. Upper air flow gradually becomes stronger with more outbreaks of colder Canadian air across the area.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the SZL Forecast Guide.

5. SEASONAL FORECAST RULES:

a. Fog forms over a good snow cover (normally two inches or more) when the dewpoint reaches 32°F.

b. If McConnell AFB gets frontal or Gulf stratus, GVW will also get the stratus.

c. Stratus clears with the passage of the 850 mb isothermal trough (all seasons).

d. Forecast stratus to break when the Dodge City (DDC) 500 mb winds shift from a southerly direction to 260° or greater (all seasons).

WHITEMAN AFB (SZL) FORECAST GUIDE

1. UNITS SUPPORTED: 2nd Bomb Wg (B-52, KC-135) alert force, 351st SMW, Det 9, 37th ARRS, MANG. Hel. minimums 700/1 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Whiteman Air Force Base lies in the rolling hills of western Missouri about 65 miles east-southeast of Kansas City. The base is situated in a slight depression with higher terrain to the south and west. The local terrain within 75 miles varies from 700 feet to 1,400 feet. Nearby moisture sources include the Missouri River 40 miles north of the base and the Lake of the Ozarks 40 miles southeast of the base. Neither of these sources is believed to be a significant influence on SZL weather. The runway is oriented 01-19, and its elevation is 869 feet.

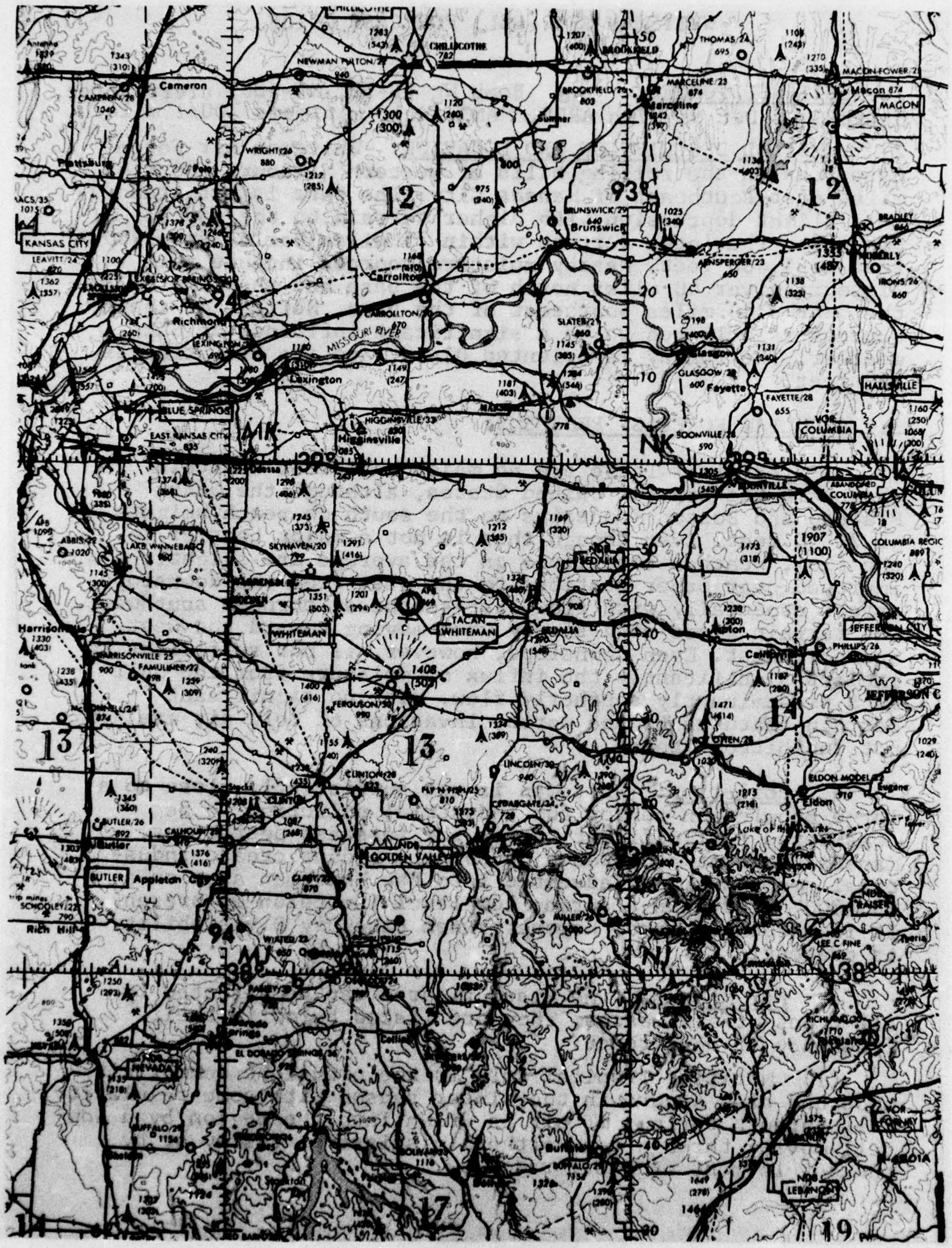
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: There are no major east-west mountain chains in the central United States, although the Ozark Plateau and Boston Mountains to the south do reach heights of 2,800 feet. Even though this is not a major barrier to the flow, weather conditions on the average are slightly improved over other stations to the west from the downslope effect especially with flow east-southeast through southwest. The terrain rises very slowly when moving toward the west and northwest. Even downslope, however, is not sufficient to inhibit significantly the influx of moisture from the Gulf in a predominantly southerly flow. With no significant terrain features to the north, invasions of cold air are not inhibited either.

b. Pollution: Whiteman is not sufficiently close to a large population center for industrial pollution to be considered a significant factor for forecast operations. Kansas City, at a distance of 65 miles, does create industrial smoke which is advected into the Whiteman area on a 290-300° wind when a strong low-level inversion is present. It is extremely rare, however, when category D visibility is present.

c. Air Masses: The Missouri area can be affected by all types of air masses. They are listed below in their frequency of occurrence:

(1) Maritime Tropical (mT) is the prevalent summer air mass and also occurs in the winter season with some regularity. Fall through spring, mT air is drawn into the region by a low cell moving through the northern Mississippi Valley or by the development of a Colorado Low.



CHILLICOTHE
Cameron
Brookfield
Marceline
MACON
Macon
KANSAS CITY
Carrollton
Brunswick
Richmond
MISSOURI RIVER
Lexington
Glasgow
Fayette
HALLSVILLE
BLUE SPRINGS
EAST KANSAS CITY
Higginsville
COLUMBIA
BOONVILLE
SEDALIA
WHITEMAN
TACAN WHITEMAN
Sedalia
JEFFERSON CITY
Harrisonville
CLINTON
GOLDEN VALLEY
Eldon
Lake of the Ozarks
BUTLER
Butler
Appleton City
Rich Hill
KAISER
NEVADA
LEBANON
Buffalo
Bolivar
12
13
14
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19
93
94

(2) Modified maritime polar (mP) air is found throughout the year. It is brought into the region by Pacific occlusions which move across the northwestern United States. This is the type air mass most commonly associated with fast-moving cold fronts (Type B).

(3) Continental polar (cP) air moves over the area throughout the year with greatest frequency in the summer. The cP air mass is often brought in behind as a secondary cold front as a low system moves across the Midwest. Except in the summer, cP air is significantly colder than mP air (Types A, D, sometimes C).

(4) Continental arctic (cA) air brings the most bitter winter weather to this region. When the upper air pattern adjusts so that a series of highs move southward out of Canada, the latter ones of the sequence bring cA into the Whiteman area (Types E and E_s).

(5) Superior (S) air occasionally moves into the SZL area from the late spring to early fall. Southwesterly winds in some depth are required for this type of advection. This air is typified by increasing temperatures, decreasing moisture content, and thunderstorm potential.

c. Fronts: As with air masses, all types of fronts come through Missouri. Cold fronts are the most frequent and usually the best defined of all fronts. They are best observed preceding a strong polar (or arctic) high which has a large southward component of movement. When cold fronts have originated as a Pacific front and have moved across the Rocky Mountains, they are often diffuse. Cold fronts are subject to frequent frontolysis in this area. Cold frontogenesis rarely occurs closer than southern Canada.

Stationary fronts present a great forecast problem. Often they are diffuse with little associated weather; however, when well-defined and located just south of SZL, accompanying overrunning weather can be a great hazard (Type C). Thunderstorms are frequent in such cases during the spring and fall. In the winter, freezing precipitation as well as an occasional thunderstorm can occur. Frontogenesis of stationary fronts is almost always associated with cyclogenesis. A developing low will bring mT air into a zone of contrast with modified mP or cP. Frontolysis usually occurs after a cold front has become stationary.

Warm fronts are with rare exceptions associated with cyclogenesis in the Texas Panhandle or in Oklahoma or Kansas and originate in the same manner as new stationary fronts (Types D and E). Occasionally cold fronts that become stationary move north again as warm fronts. In this case, overrunning phenomena will usually continue to occur.

Occlusions will occasionally pass through the area. They are normally recently formed by cyclogenesis in Kansas or Oklahoma. The low center must necessarily track just to the north of the SZL area. Pacific occlusions that survive passage over the Rockies move well to the north of the area.

d. Advection of Gulf Moisture: Maritime tropical (mT) air is under certain conditions of southerly flow advected into the Whiteman area from the Gulf of Mexico. Generally, the southerly flow is caused by an mP or cP air mass being positioned on the East Coast of the United States. There are commonly no important fronts present to hinder this mT advection, but the condition of the surface gradient gives rise to two distinct patterns as follows:

(1) With a weak surface gradient, the following surface and low-level features are observed; stagnation of pressure systems giving weak gradient, no low-level jet through the Midwest and insignificant surface pressure changes. The associated weather is widespread low stratus (1,000 feet), drizzle and/or fog which will advect northward into the Midwest.

(2) With a strong surface gradient, a low-level jet of 40 knots or greater appears through the Midwest along with significant pressure changes in advance of an approaching mP or cP cold front. The associated weather is the rapid advection of stratus northward. Precipitation develops as mT air settles in firmly, and a cold front (mP or cP) approaches from the west.

e. Thunderstorms: Pre-frontal squall-line activity, which is quite frequent in the spring, represents a synoptic regime of unusual severity. Although the actual duration of each squall-line is brief, the associated weather is quite significant to all phases of operation. The primary synoptic features of interest (warm moist low-level jet, dry intrusion above 850 mb and mid-tropospheric reflection of a strong jet stream) as well as the forecasting parameters are best studied in TR 200 (rev). Of particular interest to the Whiteman area is the much-debated "Ozark Effect". At times, the moist tongue is seen splitting around the Ozark Plateau. The rough terrain does disturb the low-level wind field. As a result, it seems that squall-lines tend to weaken in west central Missouri and regain intensity again further east. Thus the occurrence of heavy thunderstorm activity seems to be less frequent in the Whiteman area than in either the Kansas City or North St. Louis areas.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

WINTER

a. Type A: Front may pass SZL.

(1) Clouds: More than likely nothing. Frontal passage noted only by a drop of temperature.

(2) Visibility: Unrestricted.

b. Type B:

(1) Clouds: Advection of Gulf stratus ahead of an mP front is clearly possible. Clearing will occur rapidly after frontal passage. Some periods of D or E category middle clouds will accompany the front but are rarely extensive.

(2) Visibility: Unrestricted unless the stratus forms with drizzle ahead of the front.

(3) Precipitation: Some steady rain or showers can occur with the category D ceilings; drizzle is also likely if the stratus is advected into the area.

(4) Winds: S 5-10 increasing to 10-20 and shifting to NW or WNW after frontal passage.

c. Type C: Observed weather totally depends on position of stalled front. Normally it will be north of the station but if south expect typical overruning conditions.

d. Type D: Maritime tropical (mT) air interacting with cP air usually results in the most intense wintertime weather systems. When a northeast-southwest cold front becomes stationary through Texas or Oklahoma, a wave may develop on the front in the Texas Panhandle or somewhat further north along the lee of the Rockies. This cyclogenesis takes about 24 hours from the time the front becomes stationary and is likely to occur only if a closed low aloft is located through Colorado and/or New Mexico. High clouds range from 50-200 miles ahead of the front. Stratocumulus ceilings (1,500-2,000 feet) occur in the frontal zone, and an overcast stratus ceiling (500 - 1,000 feet) occurs behind the front. Because of the extreme discontinuity of these two air masses, the area of expected cyclogenesis will probably have an overcast of low clouds. Thick cirrostratus and altostratus layers west and southwest of Whiteman are very good indications of cyclogenesis along the front. As the low moves out of the mountains towards the northeast or east, freezing precipitation and heavy snow will generally accompany it. This situation gives SZL its heaviest snowfall only if the low center goes south of the station. If the low tracks north of Whiteman, warm front weather will be experienced.

(1) Low level winds from the east through southeast over Kansas and Oklahoma.

(2) Flat weak (low index) gradient over the Rockies with a westerly polar jet advancing to Grand Junction, Colo.

(3) Strong height falls near Dodge City and Wichita.

(4) Rapid surface falls on the lee-side of the Rockies, generally appearing during the afternoon (along with diurnal fall).

(5) Inverted trough develops in the frontal zone.

e. Type E: Cyclones from this pattern develop much like the Type D described before except that the location is further south from the Panhandle southward to the Gulf. A Gulf Low moving through Louisiana can have the same effect as a Type D low moving through southern Missouri.

(1) Clouds: Since a low from this pattern never goes north of the station, the northwest sector of the cyclone will always affect SZL. As a result ceilings lower rapidly in precipitation and remain until the precipitation stops. A strong arctic outbreak will occur behind the system. A brief return to high category B or low C ceilings is possible as the cold front passes.

(2) Visibility: During precipitation, visibility generally parallels ceiling categories. Unrestricted after snow/rain stops except briefly in showers as cold air becomes established.

(3) Precipitation: Snow normally if track is reasonably far away from the station. The track and tendency to recurve determines how much.

(4) NE 5-10 increasing to 15-30, possible higher gusts with slow backing to NW 10-20 and continuing for up to 12 hours.

5. SEASONAL FORECAST RULES:

a. Forecast surface wind peak gust (average 40 knots) 5-7 hours following initial arctic cold frontal passage. Forecast average peak wind gust associated with secondary frontal passage. Due to the sinking motion of the cold air behind the initial frontal passage and the resultant adiabatic warming, the temperature change across the arctic front is destroyed or may even be reversed. The initial front is marked only by a wind shift (average surface gusts of 25-30 knots) and a decrease in moisture content. The real temperature discontinuity observed as far as 50-100 miles behind the masked front, which is designated as the secondary front, marks the boundary between the adiabatically warmed cold air and horizontally moving current of cold air observed further behind the front. This condition occurs mainly with the Type E cold front associated with arctic outbreaks (without a cyclone moving out of Texas).

b. Do not forecast a post-cold frontal cloud clearing line (cold air stratocumulus) to reach the base from the west or north if the post-frontal surface winds are expected to assume a directional component which is east of north. Post-frontal cloud clearing lines characteristically move steadily eastward to eastern Kansas but do not continue through western (and/or northern) Missouri if surface winds in the Whiteman area shift from the west of north to east of north.

c. Do not forecast surface winds (except associated with thunderstorms) to exceed 30 knots unless a strong cold front is moving into the area from the northwest or a strong southerly flow has developed in Oklahoma or western Kansas.

d. The cold frontal situation typically involves a strong polar or arctic outbreak and is accompanied by a strong surface pressure gradient and strong gradient wind flow. The strong southerly flow may or may not manifest a low-level jet, but it will invariably cause surface winds (30 knots or more) over a very large area in the central United States. A typical strong southerly flow situation involves the return flow from a strong high pressure area that has moved east or southeast of Whiteman.

e. Do not forecast surface winds (except associated with thunderstorms) to exceed 34 knots unless stations in eastern Kansas or northern Missouri are experiencing surface winds of 38 knots or more. The terrain of central Missouri is somewhat rougher (i.e. more frictional dampening) than the terrain to the west and north of Whiteman. Also with a strong southerly flow, the Ozark Plateau to the south of Whiteman channels the strongest gusty flow into Oklahoma and Kansas. Eastern Kansas experiences southerly gusts earlier and stronger than Whiteman.

REGION 5

GREAT LAKES FORECAST GUIDES

K.I.Sawyer AFB	SAW
Kincheloe AFB	INR
Wurtsmith AFB	OSC
Selfridge AFB	MTC

K.I. SAWYER AFB (SAW) FORECAST GUIDE

1. UNITS SUPPORTED: 410th Bomb Wg (B-52, KC-135), 87th FIS (F-106), 43th ARRS (Helicopters). Additional amendment criteria are 300 feet and/or 1 mile.

2. LOCATION AND PHYSICAL DESCRIPTION: K.I. Sawyer Air Force Base is located 12 miles south of Marquette, Michigan at a field elevation of 1220 feet MSL. The base is situated on a narrow plateau on the Upper Michigan penninsula 12 miles south of Lake Superior and 40 miles north of Lake Michigan. The land rises more than 600 feet from Lake Superior to the base then slowly descends southward. It is covered with heavy forest and many small lakes and streams. The runway is oriented 01-19.

3. PECULIAR FORECAST PROBLEMS:

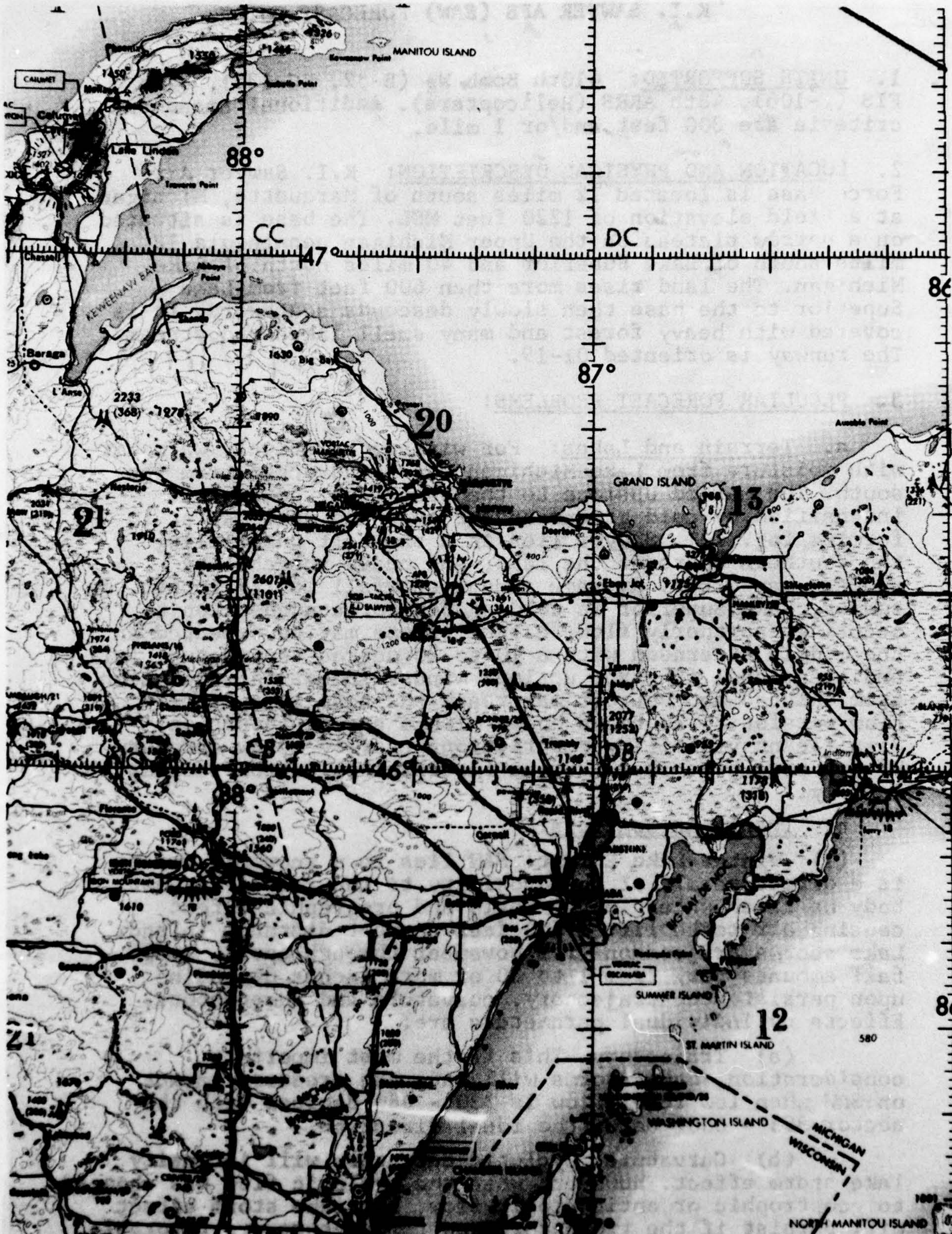
a. Terrain and Lakes: For winter, relatively warm air with moisture from Lake Michigan may be advected from the south. The marked upslope to the base from the lake is intensified by cold ground and/or snow and will assist in forming fog. K.I. Sawyer lies in a snowbelt paralleling the southern shore of the lake, and heavy instability showers may occur. Average annual snowfall is 127 inches. In summer, Lake Superior is cold enough for condensation to occur. In northerly flow, a lake breeze may be expected in the middle afternoon with a 10 to 20 degree temperature fall and occasional fog from upslope winds. Industrial pollution from Chicago and Detroit may reach the base in southerly flow persisting 24 to 48 hours with a strong inversion. Significant visibility restrictions (rarely below category D) are possible. There are no important pollution sources locally.

b. Transient Controls:

(1) Winter Lake Effect: SAW lies in a snowbelt which is a direct result of the proximity to the second largest body of fresh water in the world and orographic effect causing air to be lifted 600 feet a short distance inland. Lake storms are common from November through April. Snowfall amounts vary from 1 to 30 or more inches depending upon persistence, trajectory, curvature and temperature. Effects by individual parameters are:

(a) Trajectory. This is the most important consideration. Lake storms will have the greatest impact on SAW when low level flow is 330 - 080 degrees with the sector 355 - 050° being the ideal direction.

(b) Curvature. Cyclonic curvature will intensify lake storm effect. However, when the cyclonic flow has changed to geostrophic or anticyclonic flow, the lake storm effect will persist if the trajectory and temperature are favorable.


MANITOU ISLAND
CALUMET
Lake Linden
88°
CC
DC
47°
KEWEENAW BAY
Baraga
L'Anse
2233
(368)
Big Bay
87°
20
21
GRAND ISLAND
13
2607
(1101)
46°
17
SUMMER ISLAND
12
ST. MARTIN ISLAND
580
WASHINGTON ISLAND
MICHIGAN
WISCONSIN
NORTH MANITOU ISLAND

(c) Lake - 850 mb temperature difference should be at least 13°C for significant storms. When the difference is 20°C or greater, severe storms can be expected with greater than six inches and up to thirty inches depending upon persistence. When only surface temperatures are considered, CYQT to CYWR temperatures should be equal or less than -6°C.

__Forecast__: Ceilings/visibility category B in pellets, soft hail or snow showers. Periods of moderate showers are likely. Strong instability provides conditions for intermittent category A in squalls. Equal to or less than B category will persist until trajectory or temperature becomes unfavorable.

(2) Spring Lake Effects: Northerly winds of 340-030° occur most often (30% of time) due to the land-lake breeze effect. For example in May with lake temperatures of 38oF and a pressure gradient of less than 4 mb per 250 miles, an onshore wind is likely to occur within 2 hours after the land temperature reaches 50°F. This effect is particularly true with a high center within 250 miles to the east, south and overhead. The land temperature will stop rising and will fall after the onset of the lake breeze. The onshore wind occurs primarily between early afternoon and 2300Z and will dissipate by 0100Z.

With a pressure gradient of less than 4 mb per 200 miles, a diurnal variation of wind direction and velocity is likely particularly with a high pressure area to the north and west. From 1 hour before sunset to 3 hours after sunrise, the wind direction is quite variable (usually 230-300°) with a wind speed of 8 knots or less. By mid-morning winds become 290-330° at 8-12 knots.

(3) Summer Lake Breeze: This is most likely in mT air or general stagnating conditions. Prevailing winds will be southerly but will be light and variable at SAW. Patchy stratus and fog may form on Lake Superior and infrequently be advected inland to the base in middle and late afternoon.

__Forecast__: Predominant E category with a slight chance of intermittent category C in mid-afternoon. If pilot reports have indicated extensive lake stratus conditions, as low as B category conditions __may__ infrequently occur.

(4) Southerly flow over snow cover or cold wet land: Any warm air advection from the south will pass over a great deal of snow cover and upslope conditions. While not pronounced, these effects are greater here than in most of the Great Lakes area. Additional moisture is available from Lake Michigan.

Forecast: Category C visibility in the morning. Extensive stratus and fog with drizzle is possible; category B in morning and C at other times.

(5) Southerly flow behind a migrating high or ahead of a frontal system: Produces nearly similar conditions.

Forecast: Category C visibility in the morning in the absence of a nearby front if the flow is extensive and has a long fetch. For stronger flow, category B stratus with category D visibility is preferred in the morning. This pattern begins 12-24 hours after the ridgeline moves east and blends into approaching frontal weather from the next system upstream.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES:

WINTER

a. Type A: (Alberta Low)

(1) Clouds: Category C in active system ahead of front and for 3 hours after unless lake effect sets up. If so, consider category B for over three hours more. Inactive front, forecast category E.

(2) Visibility: Category C fog and haze in pronounced southerly flow ahead of front. Retain after passage if lake effect sets up. No visibility restrictions with weak fronts.

(3) Precipitation: Brief rain and snow showers or chance of thundershowers along the front. Retain the snow showers with lake effect.

(Continental Polar Outbreak)

(1) Typical lake effect if main thrust is from the west-northwest (conforming to proper synoptic pattern) toward the east will not occur long. If the thrust is from the north pushing to the west of the Great Lakes, lake effect will be strong

(2) and (3) Consider lake effect weather.

b. Type B: Fast-moving systems resemble Alberta Lows where mP air moves from the west-northwest toward the east. Southerly flow ahead of front; some weather at front; and no lake effect.

(1) Clouds: Category B briefly at frontal passage with active front. Broken middle clouds above.

(2) Visibility: Category C with front.

(3) Precipitation: Possible showers and/or thundershowers at front.

c. __Type C__: As mentioned in the Introduction, cP or cA fronts can move through the area from the northwest. When this happens, strong lake effect will occur. The main front is a boundary between mP·cP and mT air and is quasi-stationary south of the Great Lakes. Stable waves move along it out of the main center near the Four Corners area. Overrunning conditions resemble prolonged southerly flow ahead of other active fronts.

(1) __Clouds__: Category B with diurnal improvement to C from 1600-2200Z.

(2) __Visibility__: Category B with occasional A in heavy fog, stratus and precipitation.

(3) __Precipitation__: Drizzle and freezing rain is customary. Snow flurries also possible.

d. __Type D__: This is the severe storm type with a rapidly deepening warm-type occlusion swinging into the Great Lakes. Pre-frontal southerly flow is prolonged with moisture from the Gulf reaching northern Michigan. The period of frontal overrunning is considerable. Warm-type occlusion is followed by a secondary cP outbreak. Backwash conditions and lake effect very strong especially if closed center exists aloft tending to merge with the Hudson Bay vortex.

(1) __Clouds__: Prevailing category C but A in heavy fog and precipitation near the front. Backwash, secondary front and lake effect category B in __very__ muddled pattern.

(2) __Visibility__: Generally the same as cloud categories.

(3) __Precipitation__: Drizzle or freezing drizzle is possible in southerly flow ahead of low. However, many Colorado Lows track far enough south and east that SAW stays in an east or northeasterly flow causing significant snowfall from the added lake effect. Lows passing over or just west of SAW produce moderate to heavy snow about the low itself; snow showers with the secondary cold front and intense backwash/lake effect. Isolated thunderstorms are possible along the warm-occlusion surface.

e. __Type E__: This is a milder form of the Colorado Low as far as Upper Michigan is concerned. Cold outbreaks are as bad or worse compared with Type D. Main low usually passes well to the south.

(1) __Clouds__: Prevailing category C for 6-12 hours as the low passes by on its way up the St. Lawrence River. Continental outbreak following low causes strong lake effect.

(2) __Visibility__: Category C prevails; reduced in lake effect.

(3) Light snow; heavier in lake effect.

SUMMER

a. Type B:

(1) Clouds: Avoid category D ceilings unless extensive precipitation/thunderstorm shield exists. Category C is lowest condition.

(2) Visibility: Briefly down in light precipitation and haze/fog.

(3) Precipitation: Isolated thundershowers along the cold front and wave crests especially if pre-frontal flow is moist and unstable. Otherwise, only light rain showers.

b. Type E: Lows on surface track like Colorado Low, winter.

(1) Clouds: Category C prevails around the low. Otherwise D around system and for 24 hours afterward.

(2) Visibility: Matches category C clouds and occasionally also in thunderstorms.

(3) Precipitation: Rain around the low, showers in other areas. Thunderstorms may be scattered along the warm front and isolated around the low.

Note: The Bermuda Ridge is occasionally able to force moist tropical air into the area. A high inversion and haze (as low as category C) is typical. After 36 hours, a lake breeze regime with possible light afternoon fog is possible. Morning nocturnal radiation fog may occur but is of minor importance. Isolated air mass thunderstorms may occur except over the lakes themselves. Stagnating high cells if overhead will dry out the moisture from this air mass.

5. SEASONAL FORECAST RULES: WINTER

a. Lake Superior Effect: Low air temperature (below 35°F, better even if 15°F colder than that) over open water (middle of lake rarely frozen) allowsinstability showers. They can be heavy (temperature differences great - surface 12-22°F) with category B clouds and possible A visibility. Orographic uplift to the station contributes. Surface winds are 340-040°. Ridge axis will be north-south from Winnepeg to St. Louis. Effect ends when ridge line passes through the area.

b. Southerly flow over snow cover when proplonged adds moisture from melting snow, clamps on a low inversion and generates stratus/fog. This is most likely ahead of a warm front or warm-type occlusion.

c. The worst snowstorms occur when a Colorado Low passes just to the south and deepens rapidly over Lake Huron. Look for a secondary front and backwash/lake effect lasting for days. Pray for spring!

d. Forecast snow or snow showers when cold moist advection is accompanied by a zero degree isotherm at or below 850 mb.

e. Temperature less than 35°F, cyclonic flow, north through northeast winds, forecast low ceiling/visibility and snow.

f. Heaviest snow showers occur when the temperature is 12-22°F, and the surface wind is 350-050°.

g. Type E cold fronts produce the coldest weather of the season.

SUMMER:

a. Lake Superior Effect: Expect lake breeze after 1800Z if pressure gradient is weak. Light fog may be advected over the SAW area with surface winds in the 355-050 degree sector.

b. After a strong front, northeasterly winds will cause category B or less to persist for several hours. Usually a change in low level flow away from the 355-050 sector will end it.

c. Light southerly flow or light/variable winds, expect a lake breeze 1800-2000Z.

d. After a cold front passage, north through northeasterly winds can produce fog or low stratus for up to four hours after passage.

ALL YEAR:

a. Pacific fronts may be accompanied by weather that moves rapidly toward SAW and appears to stop in Minnesota and Wisconsin, ruining forecasts of deteriorating conditions.

b. Southwest and westerly flow are rarely associated with conditions below category C cloud, D visibility. This does not include frontal weather,

c. Low level flow (surface to 850 mb) from 220-330°, forecast ceiling/visibility greater than 1000 feet/3 miles.

d. Cumulus and stratocumulus seldom dissipate until the 850 mb ridge line has passed SAW.

KINCHELOE AFB (INR) FORECAST GUIDE

1. UNITS SUPPORTED: 716th Bomb Sq (B-52), 908th Refueling Sq (KC-135).

2. LOCATION AND PHYSICAL DESCRIPTION: Kincheloe Air Force Base (INR) is located on the extreme eastern end of the Upper Michigan penninsula near the junction of the northern three Great Lakes. This is mostly flat land with marshes and forests. Lake Superior and Sault Saint Marie are 15 miles north. Lake Huron is 20 miles to the southeast, while St. Ignace (on the Mackinac Straits) and Lake Michigan are 30 miles southwest. The only sizeable land areas are Lower Michigan due south and Ontario north through east. Field elevation is 799 feet, and the runway is oriented 33-15.

3. PECULIAR FORECAST PROBLEMS:

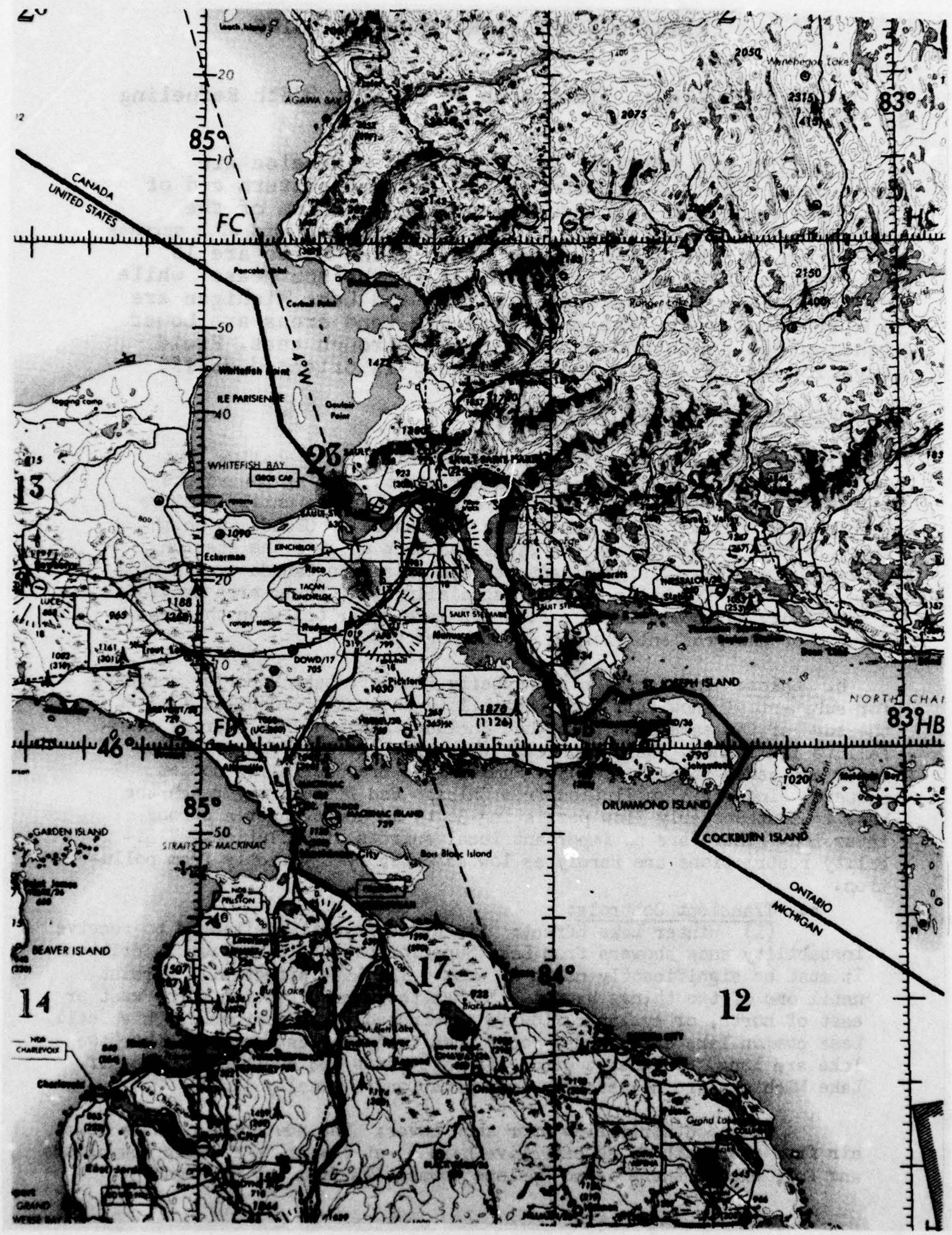
a. Terrain: INR lies on a low ridge which has a shallow (but definite) slope to the southeast and northwest. Moving toward the southeast, one does not encounter significant terrain until 18 miles to the south and southeast (along the lake shore). Clouds in northwest flow do build up along the ridge and back up over the station. Toward the northeast, significant terrain exists in Canada over a wide area. Although the hills are not especially high, their area provides a lot of drying (compared to a flow off lake Superior) when the trajectory of the gradient flow is 010 through 080.

b. Lakes: In winter, northwesterly flow off Lake Superior accounts for substantial snow fall from instability showers. Kincheloe lies on the edge of the same snow belt that includes Sawyer AFB. Average snowfall is 112 inches. Warm southeast flow off Lake Michigan over snow cover can cause fog and status. Summer lake breezes follow no set pattern. Industrial pollution from Chicago and Detroit may reach the base in southwesterly flow persisting 36 to 48 hours under a strong inversion. There are no important local sources of pollution. Visibility restrictions are rarely as low as category D strictly from pollution.

c. Transient Controls:

(1) Winter Lake Effect: Kincheloe is well positioned to receive instability snow showers from Lake Superior but the direction is critical. It must be significantly north of west. The lake effect will persist until one of two things happen. Either the wind direction turns west or east of north, or cyclonic flow is terminated by an approaching high cell. Less common lake effects may occur when trajectories over the other two lake are long. Southeast winds off Lake Huron and southwest winds off Lake Michigan are necessary. Precipitation is usually light.

(2) Southerly flow over snow cover: The advection of warm moist air from the south is as effective here as at Sawyer in forming low clouds and fog, except there is no upslope toward INR from any quadrant.


CANADA
UNITED STATES
FC
GC
HC
FB
HB
85°
83°
84°
46°
WHITEFISH BAY
ILE PARISIENNE
Whitefish Point
GROS CAP
KINCHELOE
ST. JOSEPH ISLAND
DRUMMOND ISLAND
COCKBURN ISLAND
MACKINAC ISLAND
STRAITS OF MACKINAC
Bois Blanc Island
GARDEN ISLAND
BEAVER ISLAND
CHARLEVOIX
ONTARIO
MICHIGAN
NORTH CHAN
AGAWA BAY
13
14
17
12
23

Forecast: Ceilings and visibility are category C in stratus/stratocumulus and light snow flurries. Substantial advection ahead of approaching warm fronts may lower conditions to category B in fog and stratus. Note: Conditions to the south may not appear to warrant this forecast, but warm fronts tend to stall south of the Mackinac Straits allowing such conditions 4-6 hours sooner than frontal movement would indicate.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: (WINTER)

(1) Alberta Low:

(a) Clouds: Typically category B (C if precipitation period is short) in active frontal system and up to three hours afterward. Lake effect is not likely because of critical wind direction.

(b) Visibility: Category C if warm flow over snow cover is pronounced. Retain through frontal passage and for 1 or 2 more hours.

(c) Precipitation: Brief snow squalls unless low center passes to the south of station, in which case, precipitation will be more general.

(2) Continental Polar Outbreak:

(a) Clouds: Lake effect possible with northwest winds if main thrust of cold air is right over the Great Lakes. Clouds clear up as soon as ridgeline moves close to the station.

(b) Visibility: Reduced only in lake effect.

(c) Precipitation: Instability showers.

b. Type B:

(1) Clouds: Resembles less-intense Alberta Low. Category C possible with active systems but more likely D.

(2) Visibility: Category D likely.

(3) Precipitation: Brief showers with front.

c. Type C: Fronts of cA origin may pass station and either wash out or become stationary south of the station. Further south is the main polar front which is a boundary between mP·cP and mT. Weather with passage of the cA front resembles Type B or A. Lake effect showers are possible. If the main polar front is quasi-stationary south of INR, overrunning conditions can be expected further enhanced by waves moving along the front.

(1) Clouds: Category C is usual, perhaps category B in heavier stratus situations or with passage of waves.

(2) **Visibility:** Usually category C. May be A near front.

(3) Precipitation: Freezing rain or drizzle (possible snow), rain is usual. If the front is less than 300 miles south and is active, isolated thundershowers are possible.

d. **Type D:** (Warm-type occlusion into Great Lakes, low aloft)

(1) **Clouds:** Category C is basic ceiling with periods of category B in precipitation. Heavy instability showers will follow if a secondary cold front passes the station. Position of the low on the surface is critical. It must be located in such a way to allow northwest flow.

(2) **Visibility:** Same as cloud categories.

(3) **Precipitation:** Drizzle or freezing rain mixed with snow as occlusion approaches. Will turn rapidly to snow after the low moves to the east. If the low remains south of INR through its entire life cycle, precipitation will be all snow. The low center must cross the center or northern part of Lake Huron to cause more than 2.4 inches to fall.

e. **Type E:** Milder form of Type D usually passes to the south.

(1) **Clouds:** If the low passes closer to the station than would be expected, treat like Type D. Otherwise, category C ceilings should be forecast.

(2) **Visibility:** Same category as clouds.

(3) **Precipitation:** If low passes southeast on normal track, only light snow expected with some increase if any northwesterly flow sets up after low has moved into the St. Lawrence.

SUMMER

a. **Type B:**

(1) **Clouds:** Generally scattered conditions unless the front is very strong or if center-of-action is just north of the station. Under those conditions, forecast 6 hours of category C. If the low is south within 50 miles, forecast category B. (or just south).

(2) **Visibility:** Unrestricted

(3) **Precipitation:** Isolated thunderstorms with some increase in coverage along the front.

b. **Type E:**

(1) **Clouds:** Category D persisting for 12 hours with occluded front. A short period of category C is possible if the front is strong.

(2) <u>Visibility</u>: Generally above category D except in showers.

(3) <u>Precipitation</u>: Showers along front. Steady precipitation is not likely.

<u>Note</u>: The Bermuda Ridge is occasionally able to force moist tropical air into the area. A high inversion and haze (as low as category C) is typical. After 36 hours, a lake breeze regime with possible increase of cloud cover may occur, but its pattern is not regular. Isolated air mass thunderstorms may occur except over the lakes themselves. Stagnating high cells when overhead will dry out the moisture from this air mass.

5. <u>SEASONAL FORECAST RULES</u>:

a. In the spring and fall, watch for a persistent fog or low stratus setup when snow cover and warm southerly flow exist .

b. With rapid clearing after a cold frontal passage (spring through fall) just prior to or following sunset, consider radiational fog with category A conditions by sunrise and possibly several hours before.

c. With the onset of anticyclonic northeasterly flow, surface winds greater than 5 knots, expect rapid improvement within 1-3 hours.

d. With a warm front approaching from the south, consider the possibility of the front slowing down or stalling over the Mackinac Straits and producing category B or A conditions at INR (not observed upstream).

e. When forecasting for a synoptic system which normally provides regular southeast flow, forecast weather 4-6 hours of what extrapolation would indicate. Snow ceilings are low category C (or high category B). Fog and stratus category B. Conditions upstream are not usually indicative of Kincheloe weather.

f. Watch for pinwheel troughs that form with low pressure to the north or northeast of Kincheloe. This situation is ripe for snow shower activity in surges.

g. When temperatures are below zero with the $T-T_d$ less than five degrees, watch for rapid fog formation around sunrise. If winds are calm or light and clear skies essentially exist, this condition will continue for 1-2 hours past sunrise. If clouds move in, the fog will last longer. If the winds are over 5 knots, the condition will be of very short duration.

h. Watch for the formation of cyclonic circulation to the southeast of INR on the front side of a ridge moving in from the west or northwest. This will hold the cloudiness in for a longer period than would be normally anticipated. This situation is easily recognized with streamline analysis but does not usually show up on pressure analysis.

i. With normal lake effect, a wind direction of 270-290° will cause snow showers at SSM not INR. The cutoff point is at about Dafter. If wind shifts to 300-330°, the snow will move to INR. Winds of 120-160° and 210-240° will also give lake effect snow showers (lighter).

j. Thunderstorms are mostly associated with frontal activity in the INR area. They can occur as much as 200 miles ahead of occluded systems and with east-west oriented stationary fronts which are as far south of the station as 300 miles.

k. When streamlines depict convergent flow off a moisture source, stratus and precipitation is indicated.

l. If weak divergent surface flow prevails over a low level moisture source, fog formation or low stratus is indicated depending upon the surface winds speeds.

m. Stratus associated with a low pressure center will form on the anticyclonic side of the asymtote convergence line leading into the low.

n. Streamlines are very useful in depicting upper level convergence and divergence and serve to indicate graphically the meteorological situation to which the following apply.

(1) Upper level divergence over low level convergence equals upward vertical motion indicating suspected areas of thunderstorm activity, maximum cloud cover and/or precipitation.

(2) Upper level convergence over low level divergence equals downward vertical motion either a clearing trend or the formation of a low level inversion through subsidence.

WURTSMITH AFB (OSC) FORECAST GUIDE

1. UNITS SUPPORTED: 379th Bomb Wg (B-52, KC-135), 110th TAC (ANG O-2, Battle Creek).

2. LOCATION AND PHYSICAL DESCRIPTION: Wurtsmith Air Force Base is located near the east central Michigan coastline of Lake Huron, (west side) just northeast of Oscoda and Saginaw Bay. Terrain is mostly flat slowly rising to the west about 1,000 feet in 70 miles. Lake Huron moderately influences the local climate, despite its location being downstream from the prevailing wind. Even though they are across the state, Lakes Michigan and Superior also exert some influence. Field elevation is 634 feet, and the runway is oriented 24-06.

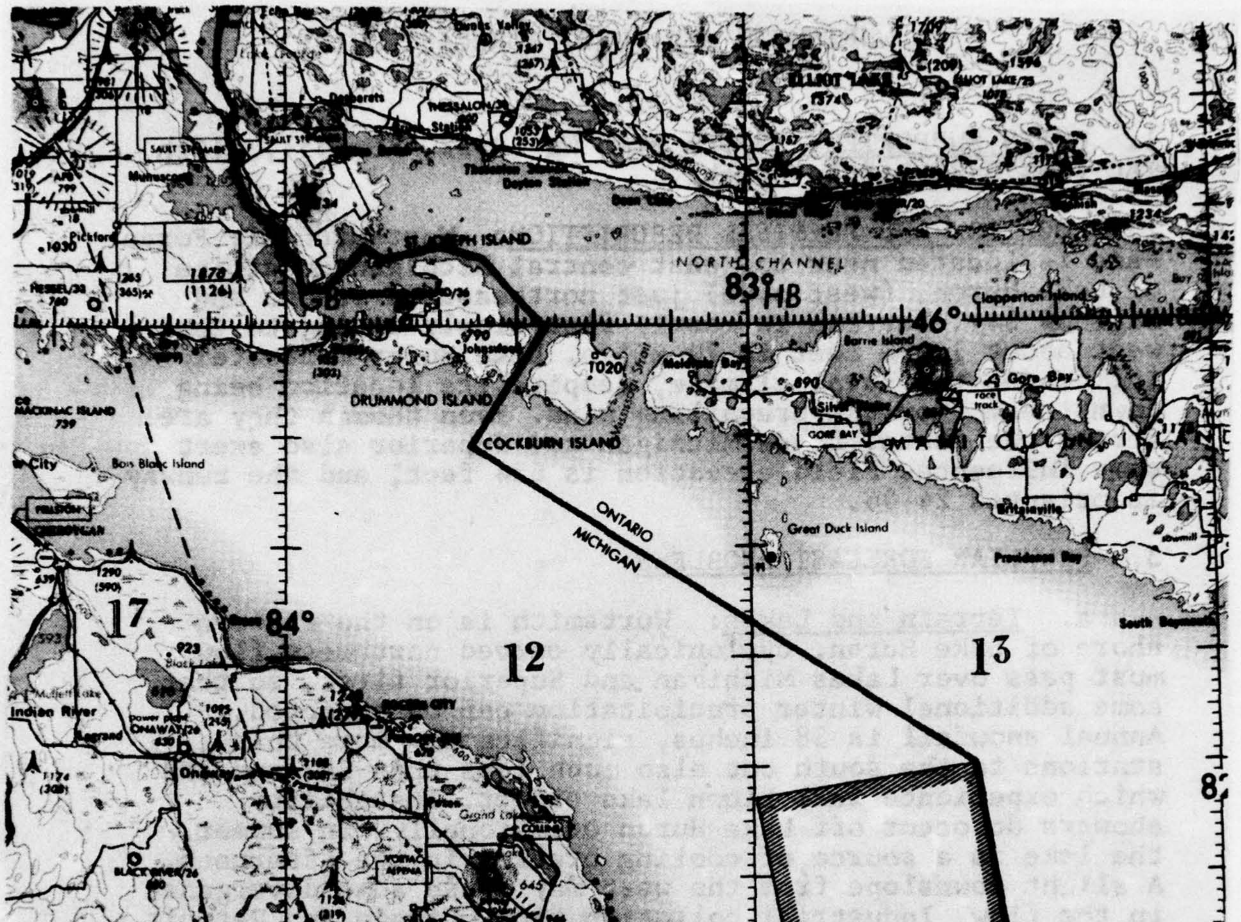
3. PECULIAR FORECAST PROBLEMS:

a. Terrain and Lakes: Wurtsmith is on the western shore of Lake Huron. Cyclonically curved northwest flow must pass over Lakes Michigan and Superior first, so that some additional winter precipitation can be expected. Annual snowfall is 58 inches, significantly more than stations to the south but also much less than SAW and INR which experience full blown lake effect. Instability showers do occur off Lake Huron occasionally. In summer, the lake is a source of cooling breezes in the afternoon. A slight downslope from the west may cause some divergence in the flow. Industrial pollution from Chicago and Detroit will reach the base in prolonged southerly and southwesterly flow after 36 to 48 hours. Occasionally haze will reduce the visibility to D category. Additional pollution from local population centers to the south and southwest provide additional significant contributions.

b. Transient Controls:

(1) Winter Lake Effect: Wurtsmith receives snow in cyclonic flow off the Lakes to the west and northwest when flow is from those directions. Northeast winds off Lake Huron are less important because they are less common. The lake effect may begin a few hours after frontal passage and last up to two days depending upon the degree of instability. Winds turning to due west or southwest as a ridgeline passes through turn off the shower activity.

Forecast: Category B in showers, rarely A for either precipitation alone or stratus alone.


NORTH CHANNEL
ST. JOSEPH ISLAND
ELLIOT LAKE
Clapperton Island
Barrie Island
Gore Bay
DRUMMOND ISLAND
COCKBURN ISLAND
MACKINAC ISLAND
Bois Blanc Island
ONTARIO
MICHIGAN
Great Duck Island
Providence Bay
Indian River
Hubbard Lake
83°
84°
46°
45°
17
12
13
16
08
LAKE HUR
R-4207
CANADA
UNITED STATES

(2) Southerly Flow with Snow Cover: Warm moist air from the south overrunning snow cover is not as much of a problem as at SAW and INR, so it is treated with the synoptic types which cause it. Forecast C category stratus and light fog.

(3) Summer Lake Breeze: A local study has verified that there is a genuine lake breeze caused by unequal heating at Wurtsmith. Prevailing flow aloft may be either northeasterly or southwesterly (though under 25 knots in the latter case). Surface winds at night are near calm. The sea breeze is accompanied by narrow stratocumulus lines and possible fog. Temperatures will fall 5-10°F. Forecast category B visibility when fog is expected - most likely in late spring and early fall.

4. <u>SYNOPTIC TYPES AND GENERAL FORECAST RULES</u>: See Synoptic Type Description in the Introduction.

a. <u>Type A</u>:

(1) <u>Clouds</u>: Category C along front for a few hours followed by intermittent B in lake effect showers. This will be intensified by the passage of a cP outbreak if main thrust is over the Great Lakes.

(2) <u>Visibility</u>: Category D normally except C when southerly flow preceding front is over snow cover. Unrestricted visibility possible for weak system. With lake effect, consider intermittent B.

(3) <u>Precipitation</u>: Brief showers, possible thunderstorms with front ahead of moderate or strong system. Lake effect showers possible.

b. <u>Type B</u>:

(1) <u>Clouds</u>: Fast-moving systems resemble weak Alberta Low - Type A front. Category C with active front.

(2) <u>Visibility</u>: Category D in showers.

(3) <u>Precipitation</u>: Light showers with front.

c. <u>Type C</u>: Two types of fronts are possible; cA from the northwest into the upper trough oriented northeast-southwest and the main polar front which may be quasi-stationary a short distance south of the base. The cA front should be treated like Type A.

(1) With the main polar front, overruning is extensive. Category C is likely with intermittent B with stable waves moving alongthe front.

(2) <u>Clouds</u>: Watch for sudden deterioration with precipitation. Steady category B or even A possible.

(3) Visibility: Generally same category as clouds. Fog may lower conditions to category A.

(4) Precipitation: Drizzle and freezing rain normal. Snowflurries will occur if the front is well to the south. Thunderstorms are possible if the front is close to the station.

d. Type D: The main low is apt to pass very near OSC with a well-developed warm-type occlusion swinging into eastern Great Lakes. Pre-frontal winds are out of the east giving more precipitation than would normally be forecast.

(1) Clouds: Basic category C ceiling with intermittent B or A in heavier precipitation lasts 8-18 hours. Warm-type occlusion may stall south of station and get strung out east-west across southern Michigan. In this case, category A is likely.

(2) Visibility: Generally the same as cloud categories.

(3) Precipitation: If the low center stays to the south of OSC, precipitation will be all snow. If overhead or slightly north, freezing rain and thunderstorms are likely. Precipitation does not change to all rain unless the occlusion actually passes the station. (To do so would require low center to be in western Michigan or Minnesota-Wisconsin).

e. Type E: The low center does pass to the southeast as it heads up the St. Lawrence. Abnormally strong systems, however, may recurve sufficiently to bring them into Lake Erie.

(1) Clouds: Prevailing C category intermittent B lasting for 6-12 hours. Lake effect will get set up as low moves eastward.

(2) Visibility: Same as cloud categories but rarely goes below C in this case.

(3) Precipitation: Light snow if system moves on usual track through Ohio Valley. Heavier snow if the low moves into Lake Erie. Mixed precipitation is not likely with this type.

SUMMER

a. Type B:

(1) Clouds: Generally scattered with a few hours of category C in an active system.

(2) Visibility: No problem except in occasional rain or thundershowers. Light radiation fog is possible the next morning following rain.

(3) Precipitation: Showers or isolated thundershowers.

b. Type E:

(1) Clouds: Category B near strong fronts and low centers. Otherwise, expect category C or D persisting for 12 hours with occluded systems.

(2) Visibility: Category D to occasional C in showers.

(3) Precipitation: Rain and showers near low and occluded front. Some thundershowers may occur, and a squall-line is an outside possibility along front if the low center moves west of the station.

5. SEASONAL FORECAST RULES:

a. Radiation fog throughout morning in the fall is common.

b. Minus Lake Huron, 3 inches of snow or less would be expected with most storms. Prolonged flow off Lake Huron will produce category B stratus, B or A visibility and more snow as long as winds stay out of that direction.

c. Post Cold-Frontal Gusty Surface Winds from the Northwest Quadrant: Key stations used are OSC, DLH and AUW. Parameters are sea level pressure (mb) and surface observed temperature (°C.) Steps:

$$P = DLH_p - OSC_p \qquad T = OSC_t - AUW_t \text{ (convert to °C)}$$

Northwest wind gusts for the first 6 hours after cold frontal passage are: OSC = P + T as calculated above

Note: Gusts may not always occur immediately after cold frontal passage but generally always occur within two hours. In addition, gusts may be observed longer than 6 hours. Make a recalculation as often as necessary to establish time for decrease of wind speed.

d. Forecast freezing rain when:

(1) Surface temperature below freezing (ground frozen?).
(2) 850 mb zero degree isotherm south of OSC?
(3) 850 mb zero forecast to move north of OSC while surface temperature remains below freezing?
(4) Is temperature/dewpoint spread at 850 mb less than 5°C?

Forecast freezing rain to begin when the 850 mb zero degree isotherm is forecast to pass over OSC. Keep freezing rain in the forecast until surface temperature goes above freezing or the +3°C isotherm at 850 mb passes over the station.

e. Forecasting rain versus snow:

(1) If there are no inversions on the skew-T, use the 35°F surface temperature as an indicator (or if all inversions keep temperature below freezing). If the temperature is

greater than 35°F, forecast rain; less than 35°F, snow. A mixture of the two is possible for temperatures 33-37°F.

(2) If there are no inversions, one can use the 1200 foot freezing level as an indicator. If greater than 1200 feet, forecast rain; less than 1200 feet, snow. Around 1200 feet, rain or snow possible.

(3) With skew-T, a thickness value of less than 9100 feet for the 1000-700 mb layer - snow. 9100-9400 feet - rain and snow mixed. Greater than 9400 feet - rain.

SPRING:

a. Do not forecast category A between 00-08L if at 1500L of the previous afternoon the following are true:

(1) Surface wind has northerly component greater than 10 kt.
(2) Surface wind has a southerly component greater than 13 knots.
(3) Temperature/dewpoint spread is greater than 20 degrees.
(4) Surface wind has easterly component greater than 9 kt.
(5) Surface wind has a westerly component greater than 8 kt.

b. Do not forecast A or B (same conditions as a.) if:

(1) Northerly component over 12 kts.
(2) Southerly component over 13 kts.
(3) Temperature/dewpoint spread exceeds 23 degrees.
(4) Easterly component over 12 kts.
(5) Westerly component over 14 kts.

c. Do not forecast category C if the temperature/dewpoint spread is over 23 degrees and the surface wind has a northerly component.

SUMMER

a. Cold fronts from the northwest usually lag 6-8 hours over Lakes Michigan and Superior.

b. Thunderstorms from over western Michigan drift toward the station and usually weaken. There is no such tendency with well-developed squall-lines.

ALL SEASONS

a. Stationary fronts stalling within 100 miles to the south cause haze and stratus/fog to form as low as B category. If sustained flow occurs off Lake Huron in the low levels, A category is a definite possibility.

SELFRIDGE AFB (MTC) FORECAST GUIDE

1. UNITS SUPPORTED: USAF, USAFR, USANG, USMC, USMCR, USCG, USA, USAR.

2. LOCATION AND PHYSICAL DESCRIPTION: Selfridge Air Force Base is located 22 miles northeast of Detroit and on the northwest shore of Lake St. Clair intermediate between Lakes Huron and Erie. The local area is agricultural with some marshland. Mt. Clemens, a suburb of Detroit, is two miles west. Lake Huron is approximately 50 miles north at its closest point, and Lake Erie is about the same distance to the south. Field elevation is 583 feet, and the active runway is oriented 18-36.

3. PECULIAR FORECAST PROBLEMS:

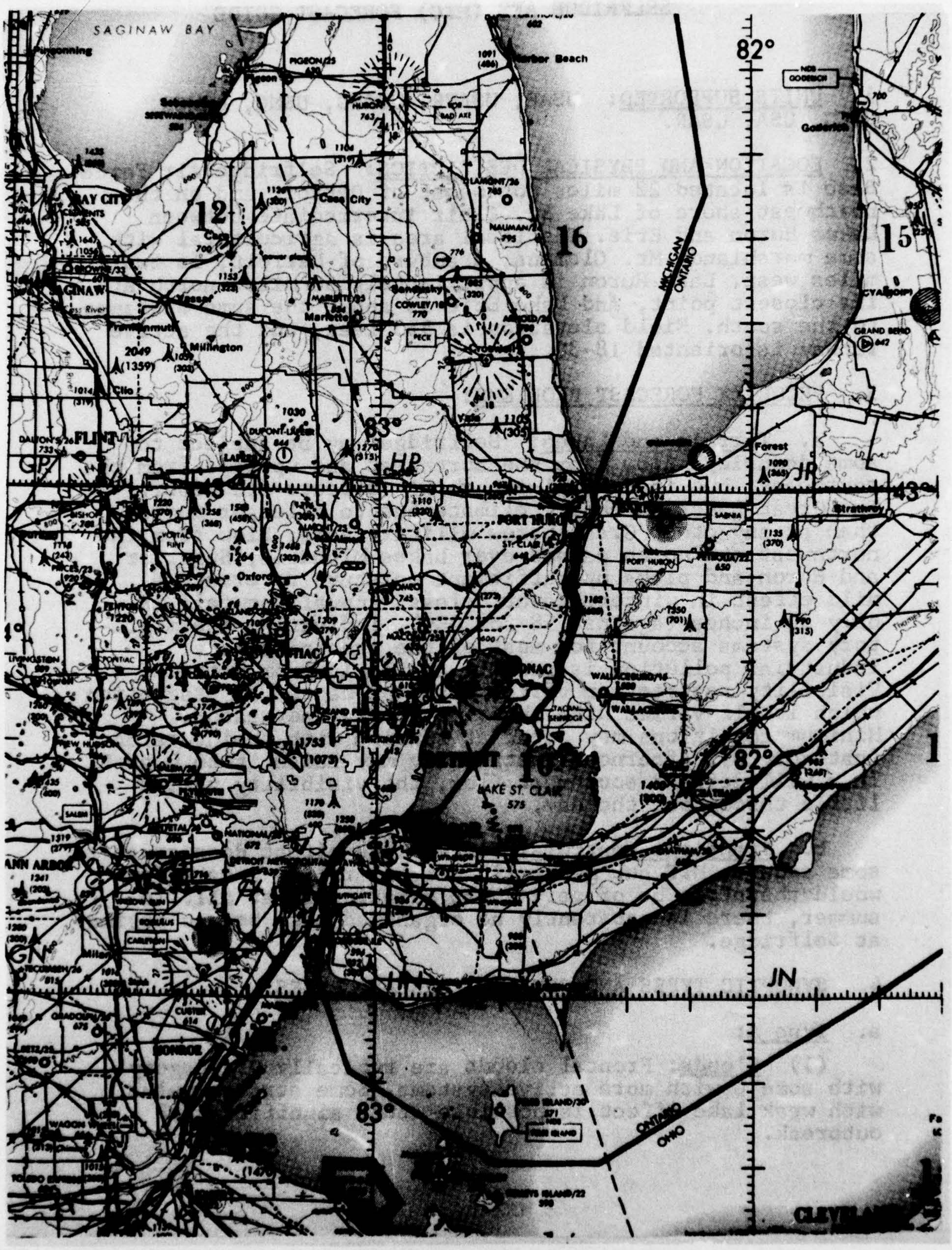
a. Terrain and Lakes: Selfridge may be subject to some downslope flow from the northwest and upslope from the southeast, but in general orographic effects are minor. The Great Lakes do modify climate but to a lesser degree than at any other Great Lakes military base. Flow from the northwest and north passes over Lakes Michigan, Superior and Huron and picks up sufficient moisture to create a mild effect in winter. Nevertheless, annual snowfall is only 30 inches (against 58 for OSC), indicating the migratory systems account for most of the precipitation. Industrial pollution is readily available from Detroit. Visibility restriction varies with the degree of stagnation which itself varies with the time of day and season. Minimum conditions may occur at sunrise with an inversion (category B). Afternoon instability may raise it to D or E. In a well-defined southwest flow, the visibility varies little throughout the day.

b. Transient Controls: Winter lake effect does cause some snow at MTC but generally only flurries. B category would therefore be of very short duration if at all. In summer, there is apparently no organized lake breeze regime at Selfridge.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES:

a. Type A:

(1) Clouds: Frontal clouds are typically D category with some C with more active systems. Some stratocumulus with weak lake effect is possible after significant cP outbreak.


SAGINAW BAY
Pinconning
Harbor Beach
82°
Goderich
BAY CITY
12
Cass City
16
15
SAGINAW
Vassar
Sandusky
Marlette
PECK
Frankenmuth
Millington
GRAND BEND
Clio
Yale
FLINT
83°
HP
Forest
JR
43°
Strathroy
PORT HURON
SARNIA
Oxford
PONTIAC
LAKE ST. CLAIR
575
ANN ARBOR
JN
MONROE
MICHIGAN
ONTARIO
OHIO
CLEVELAND

(2) Visibility: Category D or C with an active front. Slight restriction in haze and unrestricted after a weak system.

(3) Precipitation: Brief showers with weak systems. Possible thunderstorms with stronger fronts. Lake effect will produce some flurries if it gets set up.

b. Type B:

(1) Clouds: Category D generally, possible C in showers.

(2) Visibility: Category D or E.

(3) Precipitation: Light showers.

c. Type C: By the time a cold front (cA) reaches central Michigan, the weather is really like a Type A. The front to worry about with Type C is the quasi-stationary polar front strung across the upper Midwest from the Four Corners area. Overrunning conditions are extensive with waves moving along the front.

(1) Clouds: Basic category C ceiling will deteriorate to B when a wave comes up the front.

(2) Visibility: Same category as clouds, but fog may lower the category to A.

(3) Precipitation: Snow flurries with the cA front if it reaches southern Michigan. Otherwise the overruning over the polar front will cause freezing rain or drizzle. If front is right over station, then rain is a possibility along with thunderstorms.

d. Type D: The normal track of the Colorado Low is into north Indiana or southern Michigan with the triple point normally south of Detroit. The actual track is critical to the weather occurring at MTC, much more so than at other Great Lakes stations which nearly always get all snow.

(1) Clouds: Gradual decrease in ceiling to C as precipitation begins. B or A category possible in heavy snow, B in rain or freezing rain. Backwash around low will keep C category ceilings after occlusion passes.

(2) Visibility: Categories will follow clouds. If the low is north of the station, warm frontal fog may produce A category conditions. Rapid improvement after occlusion or low passes except in showers.

(3) Precipitation: Totally dependent on track of low. If triple point or occlusion approaches MTC, then freezing rain or even rain is possible. If low is southeast of station, snow only.

e. Type E: Track of low is to the southeast usually.

(1) Prevailing category C gives way to B in heavier precipitation. Lake effect will produce showers after low passes.

(2) Clouds: Period of lowest ceilings will be 12-18 hours. Again, the track of the low is critical. If it moves a little north of normal, then the period of B category ceilings will be extended.

(3) Visibility: Category C in precipitation with intermittent B.

(4) Precipitation: Light to moderate snow possibly heavy with a more northerly track. Freezing or mixed precipitation is not likely.

SUMMER

a. Type B:

(1) Clouds: Generally scattered conditions. Possible C or D ceilings for a few hours.

(2) Visibility: Haze ahead of front possibly category D gives way to improvement after front passes.

(3) Precipitation: Light showers, isolated thundershowers.

b. Type E:

(1) Clouds: Category C near the main front and associated low. Otherwise D category for 12 hours during and after occlusion.

(2) Visibility: Category C in showers.

(3) Precipitation: Rainshowers, thunderstorms. Squall-line activity possible.

5. SEASONAL FORECAST RULES:

a. Radiation fog most likely near sunrise in January and February under slow-moving anticyclone with clear skies and light winds. If gradient winds are over 15 knots, stratus will form. Moist layer should be at least 1,000 feet thick or moisture will mix with drier air above. Look for an inversion between 1,000 and 2,000 feet.

b. After a cold front, expect category C stratocumulus when winds shift to the west or northwest. Look for secondary fronts or troughs, moderate wind flow (clouds will not make it across the state in light winds) and unstable

lapse rates below the cloud layer. Cold air advection aids cloud formation; warm air advection kills it. Strato-cumulus is more likely to clear at night unless the clouds have only recently come in.

c. Snow:

(1) Type A - light.

(2) Type D - Heavy 6-8 hours if track of low is over or just southeast of station; accumulation 6 inches. Much less if low goes north of station.

(3) Type E - light to moderate if low on normal track lasts 6 hours or 9-14 hours if track north of normal. In latter case accumulation of 5 inches.

(4) Type D - low north of station: snow 3-5 hours then freezing rain and possible thundershowers if over-running air is mT from the Gulf.

REGION 6

OHIO VALLEY FORECAST GUIDES

SCOTT AFB (BLV) FORECAST GUIDE

1. UNITS SUPPORTED: 375th Med Airlift Wg, 1401st MAS.

2. PHYSICAL DESCRIPTION AND LOCATION: Scott Air Force Base lies in the very shallow Silver Creek Basin 16 miles east-southeast of St Louis, Missouri. Local terrain is very flat with high elevations within 50 miles never exceeding 350 feet above the base. In spite of this fact, the base does lie in a minor hollow. The Mississippi and Missouri Rivers merge 20 miles to the northwest. The rivers, the local Silver and Loop Creeks and Carlyle Reservoir (30 miles east) are minor moisture sources. Field elevation is 453 feet, and the primary instrument runway is 31-13.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Minor terrain effects are limited to the fog potential of local streams which is not considered to be significant in most cases. In strong radiation situations, however, the shallow bowl that BLV lies in is sufficient for cold air to collect and greatly increase the potential for fog. Local land is cultivated with the St. Louis area very nearby to the west and northwest. Pollution is a significant forecast problem. There is heavy industry west and northwest in St. Louis and Granite City 10 to 25 miles away. Automobile pollution is also important due to the high population density of the area. Local towns such as Belleville, however, are minor problems. Visibility restrictions are category D, but C is possible in prolonged stagnating circumstances.

b. Transient Controls: In the winter half of the year, Colorado and Texas Lows (Types D and E) pass through the Scott area, and associated weather will be close to the station in late spring. Continental polar outbreaks move directly at the central Midwest. In summer, southerly flow around the Bermuda High encourages air mass thunderstorm activity. Continental air does reach the area in summer unlike areas further south toward the Gulf Coast.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type Description in the Introduction.

a. Type A: Flow aloft is northwesterly with surface lows well north. Moderate continental polar outbreaks enter the area.

(1) Clouds: Active but slow-moving fronts begin with altocumulus lowering to category B stratocumulus or nimbostratus over six hours prior to passage. Verify conditions

Astoria
Rushville
Golden
Mount Sterling
BEARDSTOWN
Petersburg
Mason City
Lincoln
LOGAN/27
Atlanta
CLINTON
CAPITAL
NDB
SPRINGFIELD
Ashland
VOR
JACKSONVILLE
QUINCY
SPRINGFIELD
STANTON/23
DECATUR
Pittsfield
Winchester
Waverly
Auburn
Taylorville
Moweaqua
White Hall
Palmyra
Girard
Morrisonville
Greenfield
Carrollton
Carlinville
Nokomis
Litchfield
Hillsboro
JERSEYVILLE
Mount Olive
VANDALIA
ST LOUIS
ALTON
NDB
GREENVILLE
Greenville
Vandalia
CIVIC MEMORIAL
TROY
Warrenton
CARLYLE RES.
SALEM
CAHOKIA
SCOTT
Breese
Carlyle
CENTRALIA
ST LOUIS
BELLEVILLE
Waterloo
New Athens
Nashville
FESTUS
SPARTA
Sparta
Pinckneyville
Chester
VOR
MARION
FLAT RIVER
Bonne Terre

upstream as the ones suggested here may be extreme. A fast-moving front would have category D lowering to C category for several hours before clearing.

(2) Visibility: Category C if moderate precipitation occurs; otherwise category D in showers and light precipitation.

(3) Precipitation: Typically more showery than steady. More will fall with a slow-moving system than with a fast-moving one.

(4) Anticyclone weather: Rapid stabilization, clear skies and calm winds may allow category C sunrise ground fog.

b. Type B: Flow aloft is nearly westerly with slow-moving migratory systems moving through the Midwest - cold fronts (mP) and anticyclones.

(1) Clouds: Category D altocumulus up to six hours before front with C ceiling at fronts for three hours. Rapid clearing thereafter.

(2) Visibility: Category D at worst depending upon intensity of precipitation.

(3) Precipitation: Showers; steady precipitation not likely.

(4) Anticyclone weather: mP highs tend to stagnate. Category C haze and fog at sunrise with D at other times is typical especially in late fall and very early winter. Severe stagnation will allow category B at sunrise. If the ridge is east, some D stratocumulus may move in from the south.

c. Type C: Southwest flow aloft parallels quasi-stationary front which is almost always north of Scott. In fact, the "south of Scott" case is not even considered here. Stable waves moving along the front may kick off increased cloudiness and some thunderstorm activity south of the front.

(1) Clouds: Some category C stratocumulus south of the front (occasionally broken).

(2) Visibility: Typically category D in haze and light showers. May be unrestricted if southerly flow is strong.

(3) Precipitation: Light showers, possible thunderstorms when upper air support is available.

d. Type D: Colorado Lows move north of Scott into the Great Lakes. Definite warm sector and cold front weather to contend with. cP outbreaks are moderate (less than Type A).

(1) Clouds: Category C stratocumulus may precede cold front rising to D behind front. Deep low will backwash C or D ceilings for 24 hours after cold front passage. If a squall-line precedes the cold front, category B ceilings may occur for a couple of hours.

(2) Visibility: D or E category in pre-frontal southerly flow will improve to unrestricted after cold front. If a squall-line develops, C visibility may occur in the heavier showers.

(3) Showers with front; heavier showers in squall-line. Steady precipitation is not likely.

e. Type E: This is the most difficult system to handle at Scott as the conditions for rain versus snow are extremely difficult to handle. Usually a Type E cyclone will move southeast and east of Scott, but the advection of cold air behind the system and into it determines the precipitation type in many cases.

(1) Clouds: Category D clouds will drop to B in 12 hours and remain until the low is well into the Ohio Valley. Backwash behind the low will prolong category C ceilings for at least 24 more hours unless the low rapidly dissipates over the eastern Lakes.

(2) Visibility: Expect B category in moderate precipitation and possible thunderstorms. Once the low is out of the area, visibility will be good under the cold air stratocumulus ceiling. Occasional reduction is possible in showers.

(3) Precipitation: This is a difficult question. Normally it will start as rain due to pre-system advection off the Gulf. However, cooling at 850 will help drive the temperature down at the surface. From about mid-November through March, the precipitation will probably be snow and heavy at that (up to 12 inches). A mixture of freezing precipitation with snow (or rain) is not likely.

SUMMER

a. Type B: Fronts are weak at this latitude and have little effect at Scott. Southerly flow around the Bermuda High brings in warm humid tropical air.

b. Type E: Cold fronts pass through from the northwest. Waves may develop on the trailing edge. Some altocumulus and category D stratocumulus are common. Some thunderstorms will develop with severe weather possible. In the cooler continental air behind the front, scattered cumulus will develop and become broken if significant precipitation occurred the day before. Cold air thunderstorms are possible in the early afternoon. High cells are transient and do not stagnate in this case. The Bermuda Ridge is well off to the south. Waves that develop on the front usually do so further south, and Scott is not affected.

5. **SEASONAL FORECAST RULES:**

WINTER

a. If dewpoints to the south are higher than free air temperatures to north of front, expect warm frontal stratus.

b. Radiation fog behind fronts occurs in clear calm air from interactions of cold air with wet grounds and rivers.

c. Stratocumulus breakout is well forecast from probability.

GRISSOM AFB (GUS) FORECAST GUIDE

1. UNITS SUPPORTED: 305th ARW (KC-135), 434th AFR (A-37).

2. PHYSICAL DESCRIPTION AND LOCATION: Grissom Air Force Base lies in an agricultural area in north central Indiana. The low rolling terrain is mostly cultivated. The following local features have some meteorological interest: a low range of hills (tops less than 300 feet) beginning five miles north and extending northeastward; the Wabash and Eel River systems; and a 3000 acre lake 13 miles east. The south end of the lakes (Lake Michigan) is 75 miles northwest of Grissom. In prolonged northwesterly flow in winter, a Great Lakes effect will be experienced along with industrial pollution. Field elevation is 813 feet, and the runway orientation is 04-22.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Uniform elevations and a high degree of cultivation limit local forecast problems to nearby bodies of water where moisture for occasional morning radiation fog may be found. There are no important local sources of air pollution, but the industrial centers near the southern shoreline of Lake Michigan do produce haze in northwesterly flow. Operationally, significant visibility reductions are uncommon.

b. Transient Controls: Migrating cyclones tend to pass through the Grissom area with low centers moving both north and south of the base. The track of an individual cyclone is a real forecasting problem and makes a big difference on the weather experienced. Grissom exhibits characteristics of both the Great Lakes stations and the stations in the Ohio Valley.

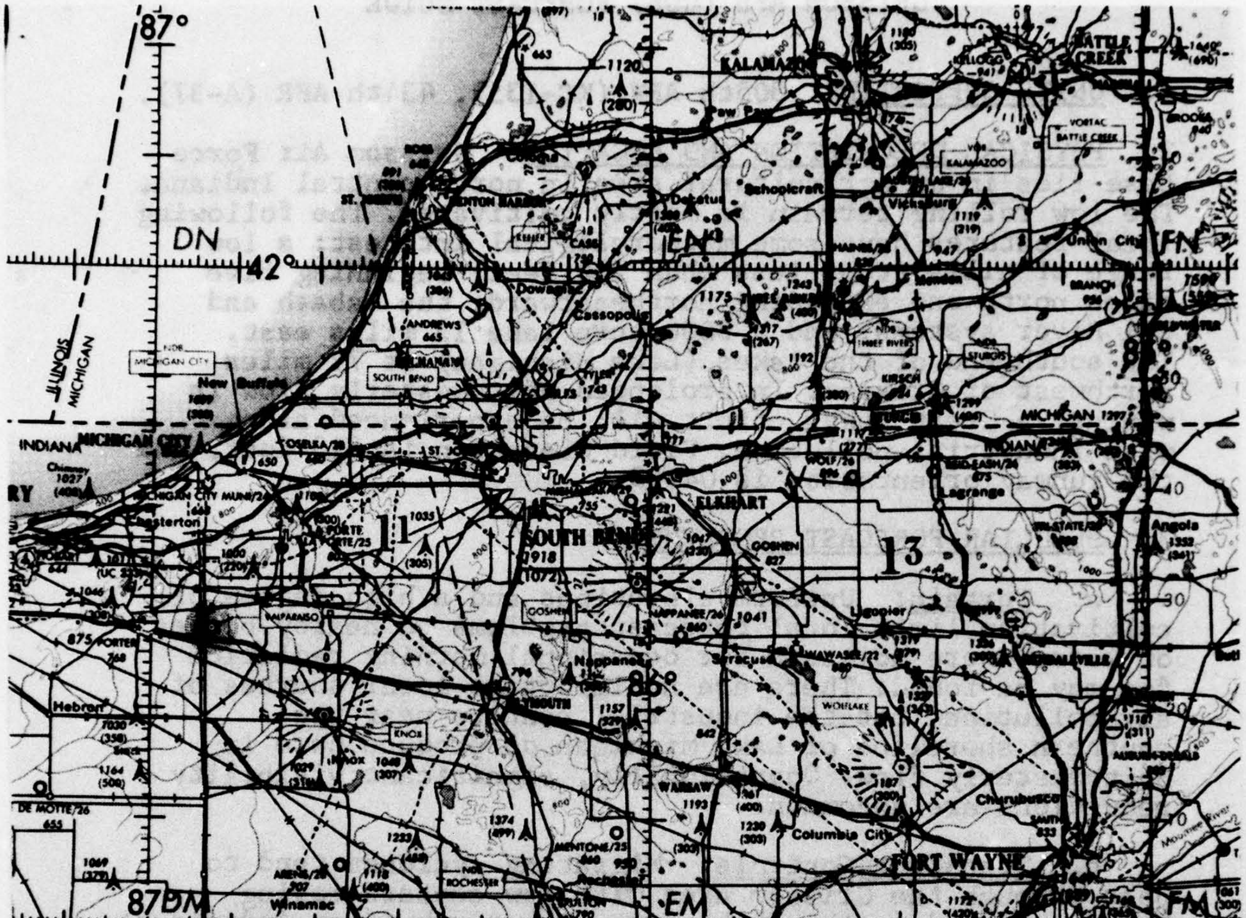
4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: A moderate trough underneath the Hudson Bay Vortex puts northwesterly flow aloft over Grissom. Strong continental outbreaks follow the Alberta Low, but lake effect this far away from the lakes is unlikely.

(1) Clouds: High middle cloud descending to category D with a short period of C right on the front. Secondary front(s) may retain continued short periods of C for 12 more hours.

(2) Visibility: Unrestricted except with showers.

(3) Precipitation: Scattered rain or snow showers; short period of heavier precipitation on main front or secondary.


87°
DN
42°
ILLINOIS
MICHIGAN
INDIANA
KALAMAZOO
BATTLE CREEK
MICHIGAN CITY
New Buffalo
SOUTH BEND
ELKHART
GOSHEN
Cassopolis
Dowagiac
Schoolcraft
Vicksburg
Mendon
Union City
Lagrange
Angola
Ligonier
Chesterton
Hebron
DE MOTTE/26
VALPARAISO
KNOX
PLYMOUTH
Nappanee
Syracuse
WOLFLAKE
WARSAW
Columbia City
Churubusco
FORT WAYNE
MENTONE/25
ROCHESTER
Winamac
87DM
EM
FM
N. Manchester
Rensselaer
Monon
GARWOOD/26
LOGANSPORT
Monticello
WHITE
WABASH
Warren
Berne
11
13
14
KOKOMO
MARION
Montpelier
PORTLAND
LAFAYETTE
FRANKFORT
SHERIDAN
Albany
DL
ELWOOD
ALEXANDRIA
Flora

b. **Type B**: Weak cold fronts followed by anticyclones which tend to stagnate.

(1) **Clouds**: Broken middle clouds with some lower stratocumulus in either D or high C category mostly on the front itself.

(2) **Visibility**: Unrestricted with front. Category B or C morning haze or radiation fog may occur with time. Near center of stagnant system, category A morning to D in afternoon is possible.

(3) **Precipitation**: Nothing significant.

c. Type C: This is more of a problem for Grissom than any other station as the quasi-stationary front seems to oscillate on many occasions from southern Indiana to southern Michigan. As a result, both possibilities need to be discussed. Stable waves move along the southwest-northeast oriented front parallel to the flow aloft.

(1) **Clouds**: If the front is north, expect periods of broken C category stratocumulus and occasionally broken middle cloudiness. If south, expect a nasty over-running situation at least category B and perhaps worse at times. In the same day, the front may be north and south of the station to further confuse matters.

(2) **Visibility**: Operates the same way as clouds. A visibility is possible if drizzle begins and if the front stays south of the station for two or three days running. If the front is north, category D in haze will be the worst condition.

(3) **Precipitation**: Snow is not likely. Freezing rain and drizzle is common. Thunderstorms also will run along the front when their support aloft is sufficient.

d. Type D: The Colorado Low track normally goes just north of the base which means that a rapidly intensifying occlusion will pass the station followed by a moderate cP secondary front. If the track is south of Grissom, it should be treated like Type E below.

(1) **Clouds**: High D category middle clouds multiple layers degenerate to C with first precipitation to B nimbostratus and back to C after frontal passage. Backwash around low may be considerable and last up to 36 hours.

(2) **Visibility**: Follows cloud categories except right on the front when conditions may reach A for a short period.

(3) **Precipitation**: Increasing steady rain or snow (possibly mixed with freezing precipitation) changing to all rain within a couple of hours of front. Showers changing to snow flurries as cold air becomes established.

e. Type E: The Texas Low is the worst storm that Grissom gets as far as snow is concerned. Normally the center should go right up the Ohio River but occasionally will recurve across Lake Erie. In either case, Grissom will have a serious storm to contend with.

(1) Clouds: D Category rapidly from cirrus level to C with start of precipitation. As the low approaches, ceilings go to B and do not rise again until the low either reaches Lake Ontario or dissipates in favor of a low along the East Coast. Ceilings will slowly rise to C but stay down for 12-18 more hours in backwash. A strong secondary cP or cA front is likely to follow which will clear things up. Lake effect is possible in very strong flow.

(2) Visibility goes down rapidly with onset of precipitation. It improves rapidly about two hours after the snow ends and only lowers with lake effect showers as winds return to the northwest.

(3) If the track is south of the station, moderate snow will fall for 9-18 hours with the upper extreme only occurring if the low recurves into Lake Erie and becomes stationary. A more likely situation is the lower extreme with 9 hours of light snow or flurries. In either case, there will be significant accumulations. Early and late in the season, the precipitation may start as rain and change over in time. Mixed precipitation is not likely unless the low center is splattered all over the Midwest (which happens).

SUMMER

a. Type B:

(1) Clouds: Thunderstorms are the biggest hazard and a D category middle cloud shield is likely. The heavier thunderstorms will cause B or C ceilings. Rapid clearing occurs after the front.

(2) Visibility: There may be some restriction in haze before the front arrives and even more in thunderstorms and showers. Rapid improvement occurs behind the front. Stagnating anticyclones are common, and reduced visibility must be considered if a ridgeline ends up close to the station. Consider also the possibility of sunrise radiation fog after a hard rain the afternoon or evening before.

b. Type E: Cold fronts with this type are much stronger, and the anticyclones that follow do not stagnate or merge with the Bermuda High. Moisture is not in such abundance as with Type B so thunderstorms are usually organized in narrow (but perhaps severe) lines. As far as weather with the fronts is concerned, there is little difference from Type B. Fog of any sort is, however, very unlikely.

5. SEASONAL FORECAST RULES:

WINTER

a. When an anticyclone stagnates over the area combined with pollution, forecast category A or B in sunrise ground fog near the center of the High.

b. Precipitation which freezes occurs with some cold fronts after passage for an hour or two. With a warm front (such as Type D) it will occur 3-6 hours in advance if the trend is towards warming, and surface temperatures are above 24°F. Freezing level is 1,000 to 1,500 feet.

c. Forecasting freezing precipitation:

(a) Is the 850 mb zero degree isotherm located to the south of GUS and forecast to move northward and pass over the station?

NO______ Stop. Occurrence unlikely.

YES_____ Continue.

(b) Is the 850 mb dewpoint depression presently less than 5° or forecast to be less than 5° at time of northward passage of the 850 mb zero degree isotherm?

NO______ Stop. Occurrence unlikely.

YES_____ Continue.

(c) Is the soil surface frozen?

NO______ Stop. Occurrence unlikely.

YES_____ Continue

(d) Forecast freezing precipitation at the time of northward passage of the 850 mb zero degree isotherm and ending with the northward passage of the +3° isotherm.

NOTE: Judgement should be used in step (c). For instance, the ground may not be frozen, but the metal surfaces (aircraft, vehicles, etc.) may be below freezing. This is also of operational significance and should be considered.

d. Lake Flow Stratus:

(a) Lake flow stratus/stratocumulus normally occurs after a cold frontal passage or an upper level (850-700 mb) trough is positioned to the west of Grissom. (Referred to as backwash earlier). This is typically a winter occurrence.

(b) Surface and gradient wind have cyclonic curvature and/or speed convergence.

NO__________Occurrence unlikely.

YES_________ Continue

(c) Temperature of the air is less than the temperature of the water (if spped of system equal to or greater than 25 knots), then stratus can occur if air temperature is greater than the water temperature.

NO___________ Occurrence unlikely.

YES__________ Continue.

(d) Surface wind direction 280-360° (if speed is greater or equal to 25 knots, include 010-050°).

NO___________ Occurrence unlikely.

YES__________ Continue.

(e) Surface temperature dewpoint depression is 5°F, forecast ceilings less than 1000 feet (B category). If the spread is greater than 5° but less than 12°, forecast C category.

(f) Duration: Forecast dissipation when the 700 mb <u>thermal</u> trough is expected to pass the station. If the system is moving at greater or equal to 25 knots, forecast dissipation when the midpoint between the 700 mb trough (height field) and thermal trough is expected to pass the station.

<u>SUMMER</u>

a. Expect category A or B sunrise pollution smog when a stagnant high center has been over the area for several days.

WRIGHT-PATTERSON AFB (FFO) FORECAST GUIDE

1. UNITS SUPPORTED: 17th Bomb Wg (B-52, KC-135), 4950th Test Wing (E/RC-135, NC-141, EC-131), Numerous Experimental Aircraft, AB Wing (Administrative and LOGAIR contract).

2. PHYSICAL DESCRIPTION AND LOCATION: Wright-Patterson Air Force Base lies in the Miami River Valley eight miles northeast of Dayton, Ohio. The wide valley floor is largely cultivated with some urbanization and is ringed by low hills (up to 500 feet higher) over ten miles away in all directions except southwest where the valley is open. Major land features of forecast interest are the Appalachians which are 200 miles east and the Great Lakes. The closest, Lake Erie, is 110 miles northeast and Lake Michigan is 170 miles northwest. Field elevation is 824 feet, and the runway orientation is 23-05.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Local forecast problems arise from the nearby Mad River and pollution. The river flows along the west boundary of the base and is a moisture source for ground fog. The major pollution source is nearby Dayton from which southwesterly winds may bring moderate visibility reduction. A weaker pollution source is the light industry near Fairborn immediately east of the base. Upsloping terrain from the south may be important when the flow is from that direction.

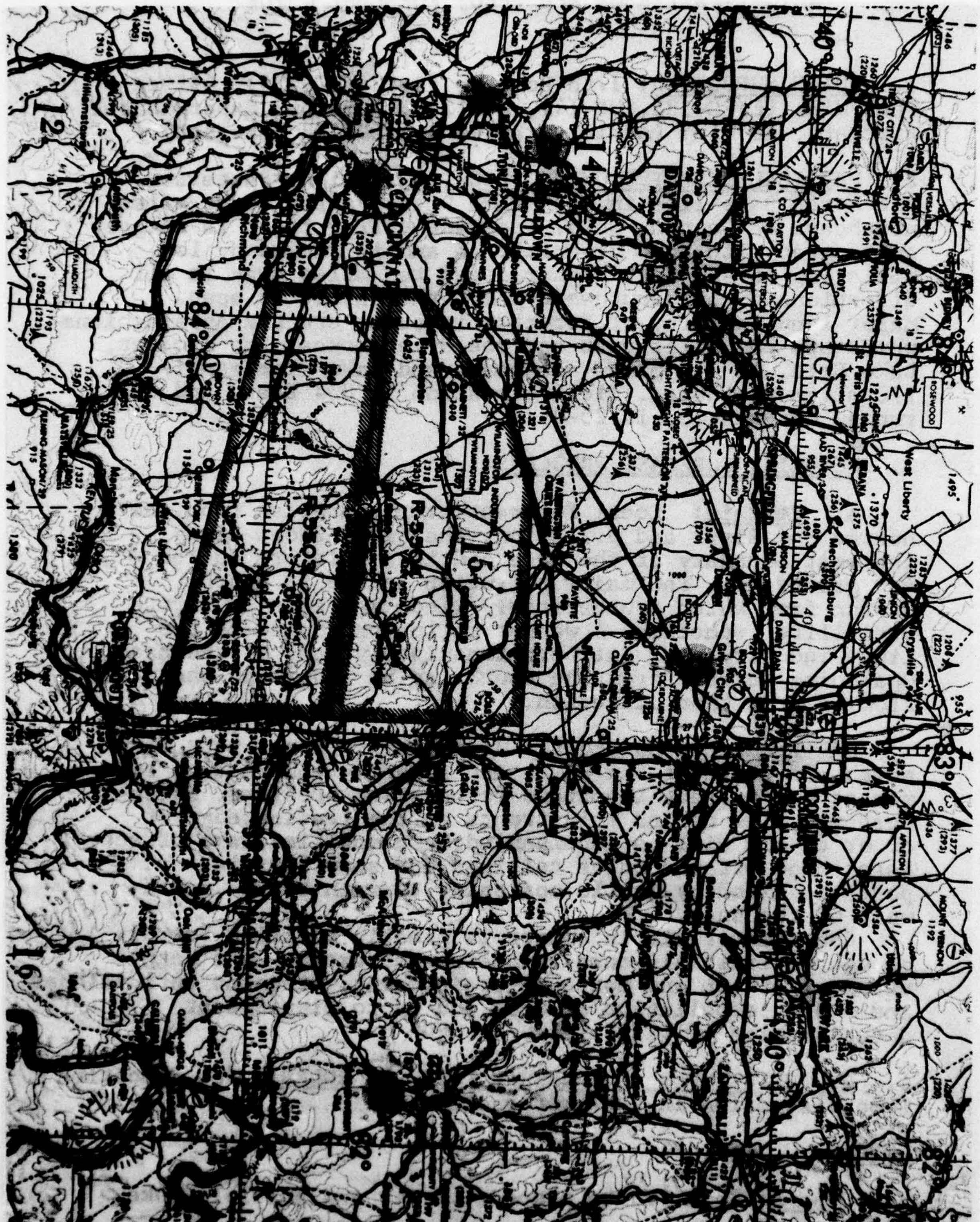
b. Transient Controls: Migrating cyclones pass both north and south of the base, and strongly contrasting air masses may present important forecasting problems. Northwesterly flow behind cold fronts on the leading edge of cP or cA air will be accompanied by a modified lake effect. Associated stratocumulus ceilings and snow flurries are possibly aided by gentle upsloping terrain to the northwest of the base.

Continental air in summer is greatly modified but dry enough to limit air mass thunderstorms except when both vertical motion and moisture are present. Stagnant anticyclones and moderate pollution sources add up to significant deterioration of visibility.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type Discussion in the Introduction.

WINTER:

a. Type A: Cold fronts precede cP air and possible lake effects.


West Liberty
Mechanicsburg

(1) __Clouds__: High middle clouds lower to category D stratocumulus ahead of the front and after if there is lake effect. If precipitation shield is widespread, category B is possible for a short while. Rapid clearing will take place behind the 700 mb thermal trough.

(2) __Visibility__: Category D is usual in showers. May be briefly C in steady rain/light snow and fog. Rapid improvement after frontal passage.

(3) __Precipitation__: Light snow or rain showers. Steady precipitation is possible but not likely with this type.

b. __Type B__: By the time one reaches this far east, Type A and Type B are virtually the same. The only exception lies in the Synoptic Type B_1 (East Coast or Hatteras Low) which may peripherally affect FFO. For forecast parameters, see type A above.

c. __Type C__: Persistent southwest flow aloft parallel to cP front which oscillates back and forth with most favored position being central Ohio.

(1) __Clouds__: If the front is north of the station, some broken C category stratocumulus is possible especially when a stable wave moves along the front. Some increase in thunderstorm coverage might also be noticed escpecially late in the season. If the front is south of the station, very low clouds possibly going to A category result especially accompanied by drizzle.

(2) __Visibility__: If the front is north, some haze may reduce the visibility to near D. If south, visibility follows the ceiling. __A__ category visibility is quite likely if drizzle occurs or if the overrunning conditions have occurred for several days.

(3) __Precipitation__: Intermittent freezing rain and drizzle. May all be melted. Snow is not likely at all. Keep in mind that front may jump north of the station in the afternoon and go back south at night. This makes the forecasting of all parameters a nightmare.

d. __Type D__: Strong lows move into the Great Lakes pushing a strong occlusion into western Ohio. This front although well supported aloft makes its way slowly across Ohio. A moderate polar outbreak occurs behind this system, but it takes 36-48 hours to become established in Ohio.

(1) Typical warm front weather from category D to low C as precipitation begins. Rapid ceiling improvement after the occlusion or warm front passes but then down to C again as backwash around low moves through the area.

(2) **Visibility**: Follows cloud categories and is worst just prior to passage of front. In the warm sector, visibility will be good except for occasional showers.

(3) **Precipitation**: Light snow or rain considerably in advance of front becoming mixed with or changing to freezing rain before becoming all rain just prior to frontal passage. (Consider thickness and other parameters to make forecast). Thunderstorms (sometimes severe) will also run along the frontal boundary. In the warm sector, organized thunderstorms are a distinct possibility and must be carefully watched. After passage of secondary cold front sometime later, snow flurries are likely.

e. **Type E**: This type is a very difficult forecast problem for central Ohio as the normal track is up the Ohio River Valley. It may reform on the east side of the Appalachians and draw in cold airmasses somewhat earlier and cause a major snowstorm.

(1) **Clouds**: Everything depends on the track of the developing storm. Ceilings will lower rapidly to B just as with the Type D and remain low until either the storm moves up the St. Lawrence or begins to dissipate over Lake Ontario. Considerable backwash will occur behind the system and maintain the ceiling near 1,000 feet for 24-36 hours especially if the low center is splattered all over Ohio, western New York and Pennslyvania which is apt to be the case.

(2) **Visibility**: Follows cloud categories. If heavy snow falls, it can go down to A. Rapid improvement will occur after the snow stops and will only be further reduced in occasional showers.

(3) Precipitation: Again, the track of the low is critical as is the advection of (or lack of) cold air. Only careful analysis will allow a good forecast. In any case, with the low going near the base and likely staying to the southeast (just barely), most of the precipitation will be snow after perhaps starting as rain. Unfortunately, mixed precipitation of every conceivable combination is also possible. Once the low moves out or begins to dissipate, the precipitation becomes showery and will remain as snow.

SUMMER:

a. **Type B**:

(1) **Clouds**: D category middle cloud shield will accompany front. Possible C in heavier showers.

(2) Visibility: Haze before front may cause D category, but improvement will occur after frontal passage. C may be observed in heavier showers.

(3) Precipitation: Organized thunderstorms may accompany front, otherwise showers and isolated thundershowers. Steady precipitation is not likely.

b. Type E: Cold fronts are stronger, and anticyclones move right on through. Change of air mass is definite. Severe thunderstorms are more likely than in type B, and the changes that take place are much more clear cut.

5. SEASONAL FORECAST RULES:

a. With a Type E, winter situation, light precipitation begins when the low reaches the LRF-MEM area. When it reaches Kentucky, the snow becomes moderate.

b. Lows tracking up the East Coast will produce category C and light intermittent snow at FFO (Type B_1). Lake effect is also likely.

c. The heaviest snows occur with Type E which passes through southern Kentucky and hugs the Appalachians into western New York State. Snow depth = 10 X precipitable water.

d. Colorado Lows (Type D) are good for 2-4 inches if the low does not pass to far west of the station. Otherwise, much of the precipitation will be rain. Showers will persist.

e. Lake effect: Northwest winds, sufficient lake-air temperature differential, cyclonic flow. Anticyclonic flow ends the effect up to 48 hours after original system passage.

f. Upslope in prolonged southerly flow of mT air is a forecast problem. If no front is forecast to pass, then 24-36 hours of B category stratus is likely.

SUMMER

a. When an anticyclone is stalled overhead, D category haze is likely in the afternoon.

b. In the absence of front or trough aloft, FFO is not normally affected by early morning fog unless nocturnal thunderstorms occur (brief sunrise fog). Afternoon thunderstorms are usually isolated, and morning fog is not likely.

c. The major pollution sources are east and southwest which according to the wind rose are the prevailing wind directions.

RICKENBACKER AFB (LCK) FORECAST GUIDE

1. UNITS SUPPORTED: 301st Refueling Wg, 302nd TAW, 121st TFW, type aircraft supported virtually everything in Air Force and Army inventory.

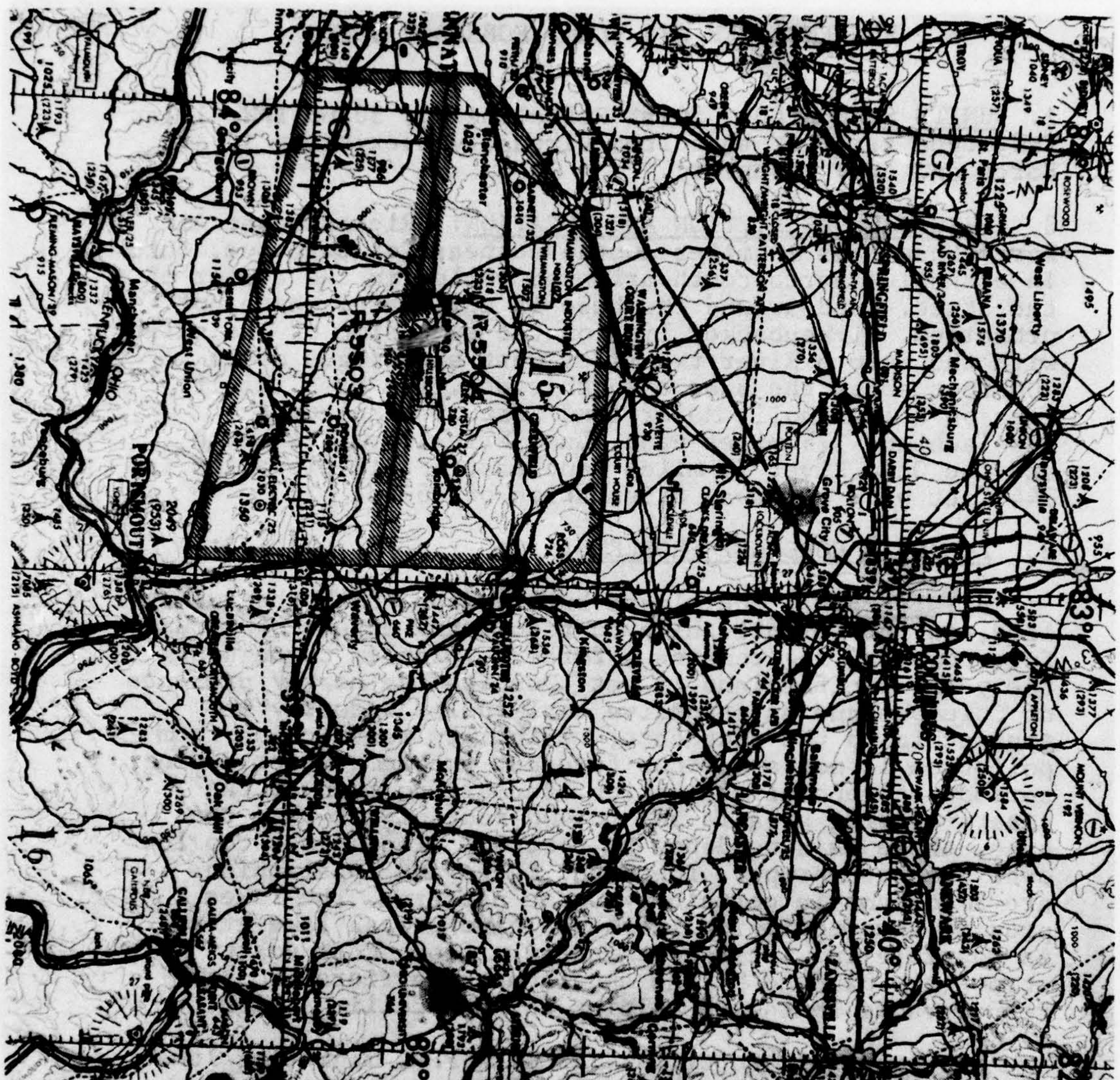
2. PHYSICAL DESCRIPTION AND LOCATION: Rickenbacker Air Force Base lies 10 miles south-southeast of Columbus, Ohio in a shallow north-south oriented valley in the center of the state. Land around the base is cultivated where not urbanized. Rickenbacker lies on the east side of the valley with the Scioto River two miles west and ridges up to 400 feet above the base on both sides. The base itself lies on a low knoll. Major land features include the Appalachians 175 miles east, Lake Erie 100 miles north and the Ohio River 75 miles southeast. Field elevation is 744 feet with a runway orientation of 05-23.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The slight knoll, upon which the runway lies, is sufficiently high to reduce the effect of ground fog. However, fog remains a forecast problem throughout the year when farmland is wet. Despite the nearby presence of Columbus and an extensive coal-fueled industry in Appalachia to the southeast, visibility restriction from pollution is not a serious forecast problem except during periods of general stagnation. Because so much of the general flying area is 300 to 400 feet higher than the base, there is a tendency to forecast cloud bases too low over the base proper. The Great Lakes and Appalachians are important in certain synoptic patterns. The lakes provide some modifying influence, and a weak lake effect is possible in winter northwesterly flow. East Coast stroms are blunted by the Appalachian barriers from Pennslyvania southward helping to keep ceilings high.

b. Transient Controls: As with FFO, migrating lows pass both north and south of the base, and to a large extent the two bases have the same "synoptic" weather. Specific wind directions for lake effect at LCK are Lake Michigan, 300-330°, Lake Huron 360-030°, and Lake Erie 050-070°. In general, look for northwesterly winds with cyclonic curvature. The pattern must be persistent, for it takes time for the cloudiness and snow showers to reach this far away from the Great Lakes. When the flow becomes anticyclonic or changes direction, the effect stops.

In summer, continental air mixes with mT air and encourages air mass thunderstorms. With more upper air support (especially in spring), severe weather occurs.


West Liberty
SPRINGFIELD
Mechanicsburg
Grove City
West Union
Kingston
Waverly
OHIO
84°
83°
82°

Stagnant anticyclones will cause haze.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Types A, B, and C: See FFO Forecast Guide.

b. Type B_1: (East Coast Storm). With any low which is close to the coast, category C ceilings and intermittent light snow will occur. The primary cause of this is a wide area of northwesterly flow on the windward side of the Appalachians which causes clouds to back up to LCK. With an exceptionally deep East Coast Low, then further lowering to B is possible with six hours of moderate snow. Just because the mountains are in the way does not mean that LCK will be free of significant weather.

c. Type D: The description of weather parameters in the FFO Forecast Guide is accurate except that ceilings go down a little more slowly at LCK in the first stages of warm front overrunning (east to southeast flow on the surface). Once the precipitation starts, there is little difference between the two. On the back side of the low, C category ceilings will remain at LCK longer than FFO with a pronounced gradient flow west through northwest.

d. Type E: If this cyclone is going to pass southeast of LCK, one has to forecast the low to move through a small space. (75 miles to Wheeling WVa.) It happens and if so the forecast weather will be much the same as FFO. However, if the low passes directly overhead or west of the base, the warm-type occlusion will pass, and precipitation will probably change to rain. Ceiling and visibility will also improve somewhat more. A stronger cold outbreak occurs with Type E than Type D, so the effect of the C ceilings holding at LCK longer is even more true with this synoptic type.

e. In summer, Types B and E behave similarly at the two stations. There are definite differences in thunderstorm coverage at the two locations from day-to-day.

5. SEASONAL FORECAST RULES

WINTER

a. In late winter, cold advection to 500 mb encourages isolated cumulonimbus in late afternoon.

b. Snow will rarely occur at LCK with a surface temperature higher than 38°F.

c. Always forecast freezing precipitation for LCK if it occurs at DAY or FFO.

d. Below minimum visibility (less than ¼ mile) due to fog will not occur more than two mornings in a row.

SUMMER

a. Radiation fog regime: Air mass thunderstorms in the afternoon or evening wet adjacent field. A clear night, radiational cooling and an east wind of 5 knots will move local fog over the runway. Higher or westerly winds tend to dissipate fog.

ALL YEAR

a. No upslope fog forms. Advection fogs are rare.

b. Most local terrain is higher than the base, up to 400 feet. Cloud bases are lower than at the base. Forecasters are often pessimistic with cloud categories.

c. The most favorable wind direction for the formation of radiation fog is northeast through southeast. (Category C not associated with a high pressure center or with weak gradient). Least favorable wind direction is southwest through northwest.

FORT KNOX - GODMAN AAF (FTK) FORECAST GUIDE

1. UNITS SUPPORTED: 1st Cavalry (OH-58, UH-1, AH-1), Aviation Center (T-42, T-41, U-21, UH-1), M.A.S.T. - ambulance (UH-1).

2. PHYSICAL DESCRIPTION AND LOCATION: Godman AAF is part of the Fort Knox installation. Fort Knox is 30 miles south-southeast of Louisville, Kentucky and lies on a ridge six miles south of the Ohio River. The installation is surrounded by rolling farm land and woods with low ridges to the south of the Ohio River. The airfield is over 300 feet higher than the Ohio River to the north and the Salt River to the east. Ridges to the south (the nearest being two miles) rise 175 feet above the field, and the Appalachians begin to rise 60 miles southeast. To the north, the Great Lakes lie 250 miles away. Field elevation is 753 feet, and the instrument runway is oriented 17-35. A secondary runway lies 15-33.

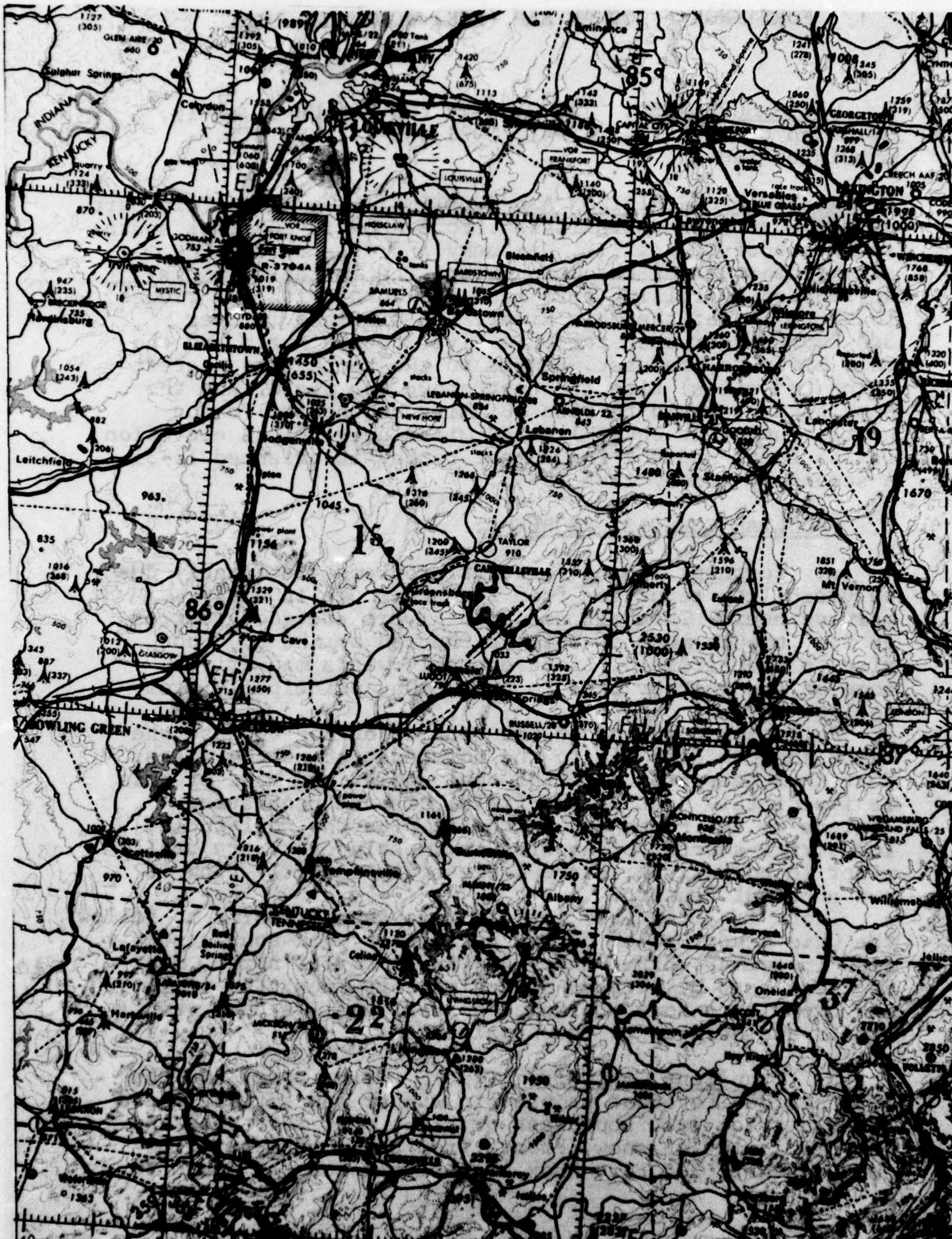
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Local forecast problems are largely due to visibility reduction from fog and smoke in early morning hours. The Salt and Ohio Rivers are good sources of fog, though much of this is checked by the 300 foot rise to the airfield. Light easterly winds may drive some of the thicker fogs to the runway principally from fall to spring.

Pollution complicates the problem of fog because the major sources also lie to the northeast about 2-4 miles. Fort Knox generates a lot of coal smoke, and most of this is immediately east of the field. Distant population centers to the north and northeast plus the coal-fueled industrial sources of Appalachia (mostly east) are really minor in comparison, since large-scale easterly flow is not a normal feature.

There is a tendency for air mass thunderstorms to follow the Ohio River Valley during periods of weak southwesterly flow in summer. Since the river is six miles north, most of these pass by without affecting Fort Knox. The field may experience some prolonged post-frontal weather when fronts are held up by the Appalachians.

b. Transient Controls: Type E (Texas Lows) are the most serious forecast problem in winter and spring. These systems track just southeast or right over Fort Knox and may drop a lot of snow. Fronts from the northwest bring good weather, and Fort Knox is a little too far south to



INDIANA
KENTUCKY
Sulphur Springs
Corydon
LOUISVILLE
FRANKFORT
GEORGETOWN
Eminence
Versailles
BLUE GRASS
PORT KNOX
R-3704A
MYSTIC
BARDSTOWN
Bloomfield
SAMUELS
HOISCLAW
ELIZABETHTOWN
Springfield
NEW HOPE
LEBANON-SPRINGFIELD
Lebanon
Leitchfield
TAYLOR
Greensburg
Mt. Vernon
Lancaster
GLASGOW
BOWLING GREEN
Albany
Celina
KENTUCKY
TENNESSEE
Lafayette
Hartsville
Oneida
Jellico
LEXINGTON
Eubank
Stanford
Monticello
Williamsburg

experience lake effect. Ceilings do hold, however, for an extended period after a cold front passage due to the Appalachians (amounts to the same thing).

Springtime storms pose the serious problem of severe weather. Squall-lines in the warm sector primarily of Colorado Lows produce good instability line activity. In summer, persistent flow around the Bermuda High provides afternoon stratocumulus and afternoon isolated air mass thunderstorms. Most summertime fronts are slow-moving and become quasi-stationary somewhere in the Southeast. There is sometimes good potential for frontal thunderstorms when quasi-stationary fronts turn warm and move back.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Flow aloft has a northerly component. Cold fronts following Alberta Low push cP outbreaks almost directly at Fort Knox.

(1) Clouds: High middle clouds lower to D category stratocumulus near front with rapid clearing after passage. If the front begins to get hung up in the hills to the southeast, the precipitation shield may become more widespread causing a short period of B conditions at Fort Knox.

(2) Visibility: D category normally unless the precipitation becomes more widespread than just showers.

(3) Precipitation: Rain or snow showers. Steady precipitation may only happen in 1 out of 4 cases.

b. Type B: Cold fronts are weaker and anticyclones more apt to stagnate. A sub-type is B_1 (Hatteras Low) which causes some precipitation and category D ceilings as it moves up along the coast.

(1) Clouds: Resembles Type A except front is more likely to get hung up so the chances of eventually having lower ceilings increases.

(2) Visibility: Same as Type A unless front stalls.

(3) Precipitation: Same as Type A except will increase somewhat with development of East Coast Low.

(4) Stagnant anticyclone: Light easterly winds may drop the visibility to C in the morning due to smoke and fog. Southerly flow on the back side may cause upslope stratus and some haze.

c. Type C: The quasi-stationary front associated with this type normally lies north of Fort Knox. Waves moving along it will cause surges in the thunderstorm coverage south of the front.

(1) Clouds: Some category C stratocumulus in light southerly flow may become broken at times. Middle clouds are also occasionally broken. Regime lasts for days.

(2) Visibility: Unrestricted although some haze will be present but not enough to forecast category D.

(3) Precipitation: Isolated showers and thundershowers as waves move along front.

NOTE: If the front is south of the field, then typical overrunning conditions are experienced; basic B category ceilings with poor visibility occasionally dropping to A if drizzle occurs. Precipitation is normally unfrozen but can freeze if conditions are right. This front is subject to strong oscillations north-south and is very difficult to pinpoint accurately in a 24 hour forecast.

d. Type D: The triple point of this system is north of Fort Knox as a rule exposing the area to real severe weather potential and classic warm front weather.

(1) Clouds: D category middle clouds drop all the way to B with overrunning precipitation ahead of warm boundary. Rapid improvement occurs after passage until cold front or squall-line show up when a brief period of B will occur again. Cold front moves sluggishly over Appalachians, and so category C ceilings hold in the Fort Know area 24 hours longer than one would expect.

(2) Visibility: Tends to follow deterioration in ceilings. Rapid improvement after cold front passage to unrestricted under ceiling.

(3) Precipitation: Classic warm front chain of events. Initial precipitation may be snow or freezing depending on advection pattern. Change to rain will occur. Thunderstorms occur along the warm front and may be occasionally severe. In the warm sector and along cold front, severe thunderstorms occur with every cyclone of this type (although in different locations each time).

e. Type E: Main low moves up the Appalachians usually southeast and east of Fort Knox. If trajectory of low is a little more from Oklahoma, the center may pass overhead or go north.

(1) Clouds: See Type D above but eliminate the improvement. Ceilings go from category B slowly up to C and then remain for over 24 hours as cold air becomes established.

(2) Visibility: Deteriorates rapidly to category B as precipitation gets heavier. Improvement occurs when precipitation stops and remains good under the stratocumulus ceiling (except in occasional showers).

(3) Precipitation: Mixed-bag. If precipitation starts as snow, it will remain snow if the low goes to the south and east. If it starts as rain, gradually the advection pattern will change it over to snow. If the low goes north or overhead, a change to rain with or without going through freezing precipitation will occur. After the low or front passes, snow showers will persist for at least 12 hours.

SUMMER

a. Type B: Weak fronts stall south of Fort Knox and may return as warm fronts. Change in air mass is not distinct. Anticyclones become stagnant quite rapidly.

(1) Clouds: Category C under thunderstorms with front and later if overrunning occurs. Occasionally broken middle clouds as well.

(2) Visibility: May be down to 6 miles in southerly flow prior to front and later with thundershowers. Further lowering in fog may occur with overrunning.

(3) Precipitation: Showers and thundershowers will continue after frontal passage if it gets hung up close to Fort Knox. Overruning drizzle may occur later.

b. Type E: Stronger fronts penetrate the area and move to Florida. Following anticyclones do not stagnate. Forecast problems are limited to the thunderstorms (possibly severe) that accompany the front.

5. SEASONAL FORECAST RULES:

WINTER:

a. Type E (Texas) Lows tracking through southern Kentucky into West Virginia produce maximum snowfall. Category C or D stratocumulus occurs 83% of time (last three years) and lasts for 18 hours at least. Snowshowers occurred about half the time when cyclonic flow over the Great Lakes existed.

b. After the passage of a cold front with a strong high to the west or northwest, considerable stratocumulus occurs during the 18 hours specified in rule (a) above.

The bases run between 2,000 and 5,000 feet with tops from 4,000 to 7,000 feet. After this initial period, skies begin to clear and remain so for a period of 24-36 hours.

FALL-SPRING

Pollution - light east winds carrying river fog and smoke. Category C (smoke) or category B (smoke and fog) at sunrise.

SUMMER:

a. Forecast sunrise radiation fog if mT air flows over moist ground (category C)

b. A majority of thunderstorms turn north with Ohio River over the bluffs on the south side.

ALL YEAR

a. Warm front with Type E: In the last three years, heavy rain occurred 12 out of 13 times.

b. A south-southwest through west wind will produce a slight downslope and improve weather faster than expected.

c. "8" vorticity value isopleth increasing at 00Z plus 12Z dewpoint of 63°F or more, gave air mass thunderstorms in the afternoon 20 out of 37 times.

FORT CAMPBELL - CAMPBELL AAF (HOP) FORECAST GUIDE

1. UNITS SUPPORTED: 101st Airborne Div., Det 1, 314th TAW. Additional amendment criteria of 300 feet and/or 1 mile (helicopter minimums).

2. PHYSICAL DESCRIPTION AND LOCATION: The Fort Campbell reservation lies in a very shallow valley near the Kentucky-Tennessee state line, 15 miles south of Hopkinsville, Kentucky, and 10 miles northwest of Clarksville, Tennessee. Local terrain is low and rolling with higher ridges being only 250 feet above the valley within 25 miles. The valley slopes 200 feet down from west to east over 60 miles, so terrain effects and upslope conditions are considered minimal. More important are the Kentucky and Barkley Reservoirs over 20 miles to the west of the base. The field elevation is 571 feet, and the runway orientation is 22-04. There are alternate runways 18-36 and 14-32.

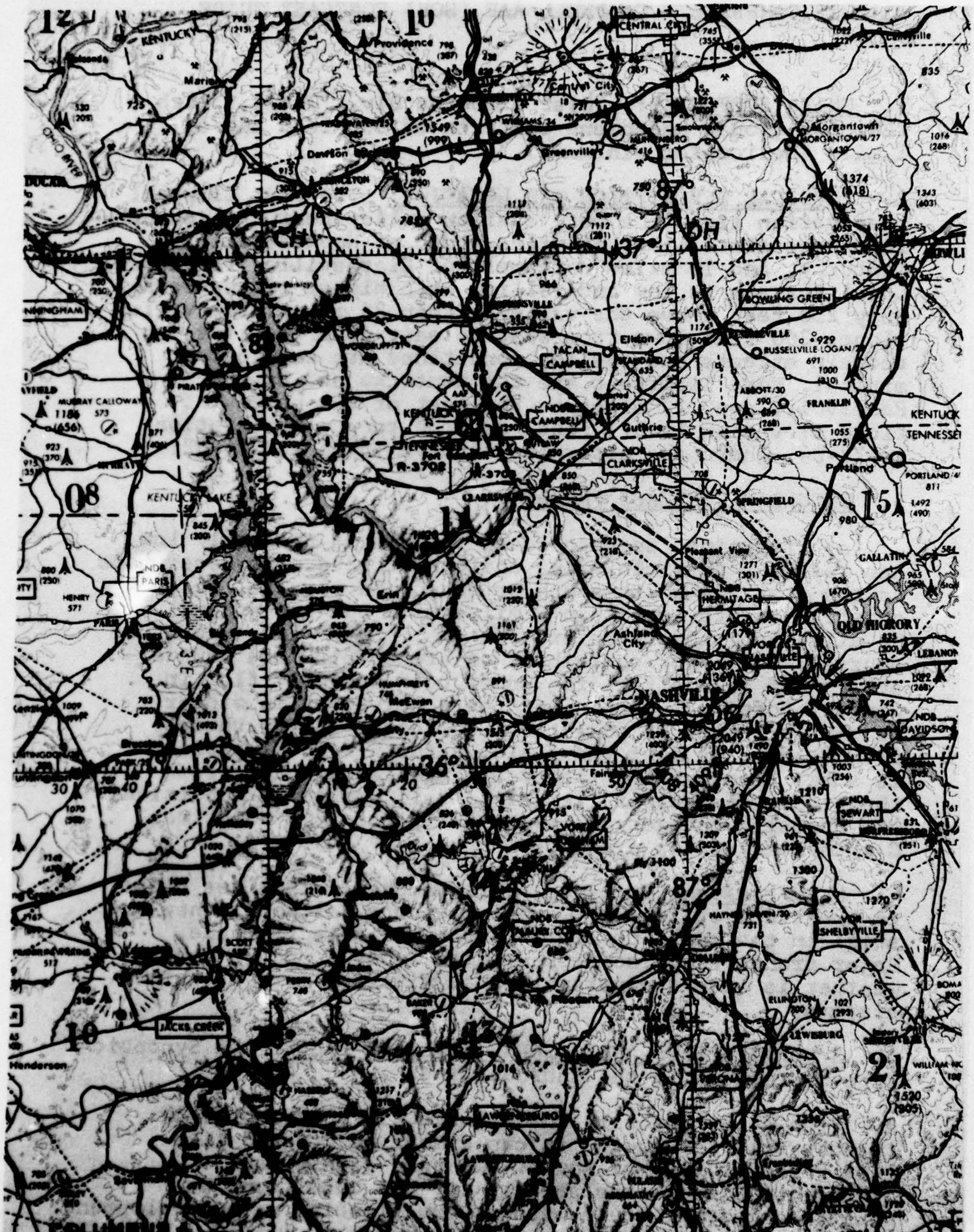
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Because local terrain is uniformly low and rolling, this minimizes upslope effects. The Reservoirs to the west are north-south oriented and parallel to each other. Both are less than 5 miles wide but are around 50 miles long and therefore are significant local moisture sources. The major contributions are to air mass thunderstorms and lake effect fog under cold westerly flow in winter. Soft coal burning at the reservation in winter is a major cause of pollution. Southeast and southwest flow draw it in over the field. A further complication is smoke from burning fields and stills advected from these same directions (largely a fall problem). Conditions are normally category D in the early morning, sometimes C when moisture is present.

b. Transient Controls: Fort Campbell also lies close to the track of Type E (Texas) cyclones, although they are still in the early developing stage at this latitude. Major fronts are also present with Types A and D. Severe weather is also a constant threat with the more organized systems.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: By the time the Alberta Low polar outbreak reaches this far south, it can almost be treated like Type B and is further south. The only significant difference lies in the ability for the cold front to penetrate further south without experiencing wave development.


KENTUCKY
Providence
CENTRAL CITY
Central City
Morgantown
Dawson
Greenville
BOWLING GREEN
RUSSELLVILLE
TACAN
CAMPBELL
Elkton
FRANKLIN
KENTUCKY
TENNESSEE
Guthrie
CLARKSVILLE
Portland
SPRINGFIELD
KENTUCKY LAKE
PARIS
HENRY
MURRAY CALLOWAY
GALLATIN
HERMITAGE
OLD HICKORY
LEBANON
Ashland City
NASHVILLE
DAVIDSON
McEwen
SEWART
SHELBYVILLE
JACKS CREEK
Henderson
LEWISBURG
COLUMBUS
R-3702
Pleasant View

b. Type B: The general flow aloft is westerly with weak troughing. A sub-type of B, namely B_1, exhibits increased troughing over the Appalachians and goes up the East Coast as a major storm. The effects on HOP are not too important. About the worst weather is D category ceiling and light intermittent precipitation. Type B cold fronts move a little more slowly than Type A, wave a little easier and stagnate more often.

(1) Clouds: Category D stratocumulus with some C along the front. B occurs if precipitation occurs over a wide area as in a stalling or waving front. Type B rarely moves through the Southeast without doing something.

(2) Visibility: An anticyclone following the front may stagnate causing smoke to be trapped and along with some fog produce C category after two days. With the front itself, visibility is normally unrestricted unless the stalling-waving process occurs close to HOP.

(3) Precipitation: Light showers with front may turn to drizzle if front stalls and is overrun by mT air.

c. Type C: Quasi-stationary front is always north of HOP. Summertime conditions prevail. Thunderstorm activity increases at times associated with upper air disturbances embedded in southwesterly flow.

d. Type D: Strong warm front approaches HOP with this type. Warm sector is ripe for severe weather. Cold front is a little sluggish at this latitude but will move through the area. Light-moderate polar outbreak behind this system.

(1) Clouds: Classical warm front weather down to category B prior to passage. Rapid improvement subject only to thunderstorm activity. After cold front passes, skies clear rapidly.

(2) Visibility: Goes along with ceiling categories. Improvement after warm front passage is to unrestricted.

(3) Precipitation: Heavy rain prior to passage of front along with embedded thunderstorms. More thunderstorms may occur in warm sector ahead of cold front. No precipitation after cold front moves through the area.

e. Type E: Major storm for the HOP area followed by strong polar outbreak. Track of low is either right over or just south of the station.

(1) Type D weather occurs except that no improvement is experienced until the precipitation tapers off, and the low is well off to the northeast. Conditions aloft will determine type of precipitation and amount.

SUMMER:

a. Type B: Fronts tend to stall to the north. The Bermuda High remains in position. The prevailing condition is mT moist southerly flow. Conditions are generally fair with occasional category D stratocumulus early in the season. Afternoon isolated air mass thunderstorms develop especially to the west over the local lakes where they may pass near the station in later hours of the evening. Heavy activity over the Mississippi Valley may be carried in southwesterly flow into the local area at night. Wet ground, calm wind and clear skies may allow brief sunrise fog to form.

b. Type E: These fronts do move through HOP, and the following anticyclones do not stagnate. The change in air mass is distinct. Severe weather is possible along the front, and showers may be heavy at times. Radiation fog is also possible but less likely due to the lower dewpoints behind the front.

5. SEASONAL FORECAST RULES:

WINTER

With cyclonic flow over the Great Lakes and a frontal passage locally, look at reports from BWG, OWB, and FTK for Great Lakes stratus. It lasts for 24 hours with brief rain or snow showers and partial clearing at night.

REGION 7

NORTHEAST FORECAST GUIDES

Griffiss AFB . . . . RME
Plattsburgh AFB . . . . PBG
Loring AFB . . . . LIZ
Pease AFB . . . . PSM
Ft. Devens . . . . AYE

GRIFFISS AFB (RME) FORECAST GUIDE

1. UNITS SUPPORTED: 416th Bomg Wg, 41st ARS, 49th FIS RADC Test Flight Division (C-135, 131), New York ANG, Capt Drumm support (helicopters).

2. PHYSICAL DESCRIPTION AND LOCATION: Griffiss Air Force Base is located two miles northeast of Rome, New York at the mouth of the funnel-shaped Mohawk Valley near the divide where the river goes into the hills east of the base. The elevation of the base is 504 feet MSL. Rome is located between Utica and Syracuse, 55 miles south-southeast of Watertown. Albany is 100 miles east-southeast of the base. RME has the distinction of having completely different weather than the other stations in the Northeast and warrants some special attention on topography and effects of water sources. There are plenty of pollution sources in Rome and nearby Utica, but these do not seem to affect the base particularly. The runway is oriented 32-14.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: This plays a very important part in forecasting for Griffiss. It is the only base in the Northeast which does not experience at least some downslope effects from deep southwesterly flow aloft. Its location is somewhat closer to the major storm tracks because of the terrain orientation. The base is open to Lake Ontario, but the slope of the terrain is only a gradual rise of three feet per mile indicating little or no orographic lift to advancing air masses from the west. The terrain to the north, however, rises to 2,000 feet in 35 miles and to the south and southwest 1,500 feet. The higher elevations of the Adirondacks lie 95 miles northeast and the Catskills 100 miles to the southeast. The arrangement of topographical features causes definite synoptic scale upslope effects in the vicinity of the station. The principle upslope problems are summer thunderstorms and winter snow showers. Flow in depth from the north and northeast does give some downslope to the station but is relatively rare.

b. Water Sources: The Great Lakes extend some 700 miles west and northwest from the RME area. Lake Ontario is the closest being only 45 miles northwest of the base and causes the principle effects on RME weather. Lake Oneida, oriented east-west, is about 15 miles from RME at the nearest point. It is approximately 20 miles long and six miles across at the nearest point. Except when completely frozen over, this water area augments the "Lake Effect". The inland waterways provide other moisture sources and drainage effects. The New York Barge Canal is


WOLFE ISLAND
Cape Vincent
Sackets Harbor
LAKE ONTARIO
CANADA
UNITED STATES
13
New Boston
Lowville
24
76°
Camden
Central Square
ONEIDA LAKE 369
Lyons Falls
Mexico
Pulaski
AQ
AP
Canajoharie

about two miles south of the base with the Mohawk River to the west. These can contribute to local fog formation. The Mohawk Valley itself extends all the way east to Albany (RME is at the mouth of the Valley). The orientation of the valley and surrounding hills has a large influence on surface wind and cold air drainage. The valley has an actual northwest-east southeast orientation which channels the surface winds predominately into these directions. Cold air drainage occurs into the RME area affecting particularly nighttime temperatures. Occasionally, a pseudo-front will form in the valley causing convergence between westerly flow and drainage which produces clouds and precipitation. If all this is not enough, most of the land around RME is poorly draining pasture land which seems to augment the fog problem.

c. Lake Effect: This is of great importance in the RME area because of its effect on flying and forecasting alike. Lake effect is most apparent from November to April. Modified lake effect is experienced the remainder of the year in conjunction with cool air passing over the warm water and is minimized during the mid and late summer months. During the winter months, the Great Lakes and to a lesser degree Lake Oneida induce considerable changes in air masses that are being advected over the Lakes. The most important area lies on the lee side of Lakes Ontario and Oneida. This area includes the southern and eastern shoreline of the lakes and extends approximately sixty miles to the east through south. Past analyses of local conditions show clearly that continental polar and arctic air masses passing over the Great Lakes absorb the lakes' heat and acquire considerable moisture. This causes the air mass to change from a stable type to a convectively unstable type over the area from the surface to a height of 3,000 feet MSL.

Obviously the air mass changes considerably in the lower levels. Within 15 miles of the station, the physical aspects of the air masses change radically since the air masses are lifted at a much greater rate of about 100 feet per mile (north and south of Griffiss). The investigation of J.J. George shows that the discontinuity between the air warmed over the lakes and cold air drainage from the land mass cause pseudo fronts to be generated. Also present in the same region is a line of convergence caused by the difference between wind velocities over the large open water surface and the higher more irregular lee side land surface. Along this line of convergence, the prevailing cloud forms are stratocumulus (winter and spring), towering cumulus (summer and fall) and occasionally cumulonimbus clouds (mid and late summer). The lake effect definitely causes a more prolonged period of low cloudiness and precipitation than would be normally expected behind a cold frontal passage.

The persistency of this cloud cover continues with wind at the lower levels prevailing west-northwest. The criteria for forecasting the occurrence of lake effect at RME are as follows:

(1) Temperature difference of 10 degrees or more between the air and water surfaces.

(2) Gradient wind between 270 to 310 degrees and 15 to 35 knots.

(3) A convectively unstable layer from the surface through 3,000 feet MSL. With the combination of all these factors, it is easily seen that lake effect is a very important weather phenomenon at Griffiss as it produces hazardous conditions for the aircraft at the base.

d. Funnel Effect: Closely associated with the lake effect is the phenomenon known as the "funnel effect". This is caused by convergence of winds near Griffiss and by the funnel shape of the entrance to the Mohawk River Valley. Thick cloud decks and heavy precipitation may persist at Griffiss when other stations have reported cessation of lake effect weather.

e. The Snow Belt: The snow belt is not strictly a geographical area. For purposes of discussion, a more accurate definition is in terms of the two key factors that make the "belt". These factors are wind direction and Lake Ontario. Although other factors, such as wind velocity, temperature and the altitude of the area enter into the picture, the keys for the belt are the first two mentioned. In order to have any appreciable snow form, the temperature differential between the lake and the land must be at least 10 degrees and the wind must have a velocity of at least 15 knots. The belt will shift with the wind direction and can be picked up on radar as a weak precipitation band within a 50 mile radius of Griffiss. The band is normally oriented along the hills.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: (See synoptic type description and Region 7 synoptic discussion).

WINTER:

a. Type B: (Typical lake effect situation)

(1) Clouds: Predominately D category middle clouds in advance of front for a short period. Deterioration to B category in snow or C in rain. Basic ceiling without precipitation is C category.

(2) Visibility: Unrestricted until precipitation starts. B category intermittent A in snow as occlusion passes, C in rain. Improvement will occur after passage but will stay down intermittently in showers.

(3) Precipitation: Moderate snow or rain depending on the time of season. Showers persist until lake effect ends.

(4) Winds: ESE 5-10 shifting to NW 15-25 and staying that way until surface ridge to the south moves eastward enough to cut off the cold air advection.

b. Type B_1: (If low is classical Hatteras, see 5. l,m,n rules)

(1) Clouds: E category ceilings with occasional D in snow showers. Situation is much worse if low is strong.

(2) Visibility: Unrestricted except in showers. (See above)

(3) Precipitation: Light snow with East Coast storm unless Lake Effect sets in. Heavy snow if storm well developed.

(4) Winds: Variable 5-10, may become NW 10-20 as low moves across 45°N.

c. Type C: See PBG for detailed description. Ceilings are generally not as low since northeast flow in depth contains less moisture.

d. Type D: Due to the western location of RME, this system will extend a warm front to the Appalachians which will approach RME as the low center goes into the Great Lakes.

(1) Clouds: Layered E category middle and high clouds lower to D with beginning of precipitation and lower rapidly to B or A in snow or freezing rain/drizzle when the front gets within 600 NM of RME. Improvement to C or D category after warm front passes. A brief period of C category ceilings and no lake effect after cold front passes.

(2) Visibility: Unrestricted becomes B category or C in precipitation, improving to E after front passes.

(3) Precipitation: Begins as snow, then changes to mixture, then to all rain. Eventually the cold front will reach the RME with snow flurries. (Late in regime)

(4) Winds: ESE 5-10 becoming variable out of south.

e. Type E: (Secondary or no secondary on lee side - makes no difference at RME).

(1) Clouds: Heavy layered clouds. Treat like Type B.

(2) Visibility: B or C category in precipitation. Will not improve much until secondary cold front passes on surface, then down intermittently in lake effect snow.

(3) Precipitation: Snow or mixture. Precipitation will continue until west side low gets well up into the St. Lawrence Valley or the East Coast low crosses 43°N, then will start again with onset of lake effect.

f. Type E_s: Treat like a Type B - generally less weather with front, but strong lake effect probable.

SUMMER

a. Type B:

(1) Clouds: Broken middle and high clouds not generally sufficient to forecast D category. Clouds below 10,000 feet usually associated with thunderstorms.

(2) Visibility: 4-5 miles in haze prior to frontal passage or thunderstorm activity. Unrestricted after.

(3) Precipitation: Showers with squall-lines or right on fronts. Thunderstorm activity is much heavier at RME than other Northeast stations, and hail is also more common. Showers cease within one hour of passage.

(4) SE 5-15 shifting to NW 15-25 and dropping off quickly. Large gusts in thunderstorms are quite possible.

b. Type B_3: No problem at RME unless front is far enough north to cause a wave to pass near the station. Severe thunderstorms can result. (See other stations further south for description of this type).

c. Type X: No significant weather. Increase in visibility with frontal passage. Watch for front returning as warm boundary with overrunning possible.

5. SEASONAL FORECAST RULES:

a. In the winter months, visibility restrictions other than precipitation or the combination of precipitation and fog are limited to occasional occurrences of radiation fog. The normal synoptic situation for fog shows that Griffiss is in a col area between two highs, or that extremely cold is advected from the hills into the valley on clear nights when the wind is from the southeast at about 5 knots. Fog will also occur on occasion following the passage of a weak front from the west assuming that the pressure gradient is weak. The fog will persist until cold trough passage occurs.

b. The winds, as indicated before, are influenced by the local terrain. With approaching lows and on the back side of highs, the general southerly or easterly flow associated with these conditions is channeled up the valley from a southeasterly direction. Gusty surface winds above 25 knots are rarely observed except in strong frontal systems. This is due to the protective terrain which surrounds the station to the east and south. The surface winds from the west through north are not affected by the funneling as much as those from the southeast, but they have a maximum from the west. Surface winds from the northwest quadrant will average 12 knots in non-frontal circulations with peak gusts of 25 knots. In

frontal activity, peak gusts are generally 30-40 knots. The forecast for winds above 30 knots should not be made except during a frontal passage, unless the 2,000 foot winds (MSL) are westerly at 50 knots. With this condition the maximum gust will be 40-45 knots.

c. Griffiss receives frequent and sometimes heavy snow showers with anticyclonic flow at the surface if the peak of the surface ridge is in the lower lakes area with the axis west of RME. With anticyclonic flow at the 850 mb level over RME, no snow showers will occur.

d. Broken to overcast stratocumulus will follow a cold frontal passage in spring, fall and winter. Bases will generally be 2-4,000 feet and will persist at least 24 hours if the low level flow continues from a west-northwest direction.

e. If the 1,000-500 mb thickness is less than 17,600 feet (5,366 meters), precipitation will be snow and not rain or freezing rain.

f. A surface wind from 210-250° does not usually persist at RME. If the gradient flow is from the southwest at less than 25-30 knots, one should forecast surface winds from 130-180° (wind usually tends to flow down the valley from a southeasterly direction). If the gradient flow is 30 knots or more from the southwest, then surface winds which will vary from 210-250° may occur.

g. When lines of convergence (moderate to heavy snow showers) can be distinctly identified on FPS-77 radar and such lines pass over RME, ceilings and/or visibility usually go below minimums for short periods.

h. To determine intensity of snow storms following cold frontal passage from November through March, check the isothermal pattern on the 850 mb chart in the Great Lakes. If four or more isotherms are packed behind the cold front and if they are oriented north-south, then the more intense and numerous the lake effect type snow showers are. If the isotherms are oriented east-west or there are less than four isotherms packed behind the cold front, then the less intense and less frequent the snow showers are. (Isotherms are 5 degree intervals).

i. Freezing rain will occur at RME for a long period of time (up to 24 hours or more) when a stationary cold high in Canada north-northeast of RME is producing NE-SE surface winds and warm Gulf air is moving aloft into this area over a stationary front south of RME. If the RME temperature is slightly below freezing in the morning with stratus and rain moving overhead, the temperature may not rise above 32-33°F for 24 hours or more.

j. The intensity of snow showers in winter is dependent upon three main factors; direction of flow across Lake Ontario, tightness of pressure gradient and degree to which the low level flow is cyclonic

k. Comment: Strong cyclonic flow such as occurs when a deep low becomes more or less stationary in the northern St. Lawrence River Valley together with gradient level winds of 25 knots or more and surface to 5,000 ft wind direction between 275-290° degrees (this will give the air the longest over-water track) will often produce conditions from 4X½SW to W0X0SW+ at Griffiss. Anticyclonic flow will tend to dampen out the snow shower activity within 40-50 miles of RME during daylight hours of winter anytime there is a northwest flow (cyclonic or anticyclonic). Conditions will generally not be less than 10X1SW- at RME during anticyclonic flow.

l. Correlation of snowfall of more than one inch per 12 hours to synoptic pattern:

Pattern	Occurrence/time	Avg 12 hr snowfall	Range
NW flow (Type B,E_s)	50%	2.4"	1.5-4.7"
Deepening low (Type B_1,E)	33%	3.5"	1.6-8.0"
Other fronts and troughs (Type C,D)	17%	1.9"	1.4-2.4"

Deepening low applies to any intensifying low approaching from the west or southwest. The lower portion of the range is applicable to the Ohio Valley low (Type E) unless a secondary forms off the East Coast which will raise the snowfall amount. The higher range is more applicable to a Hatteras Low (Type B_1). Disturbances which produce less than one inch of snow in a 12 hour period constitute the bulk of snow occurrences. The four categories of systems that produce these cases are: filling low pressure area, weak frontal system, minor 850 mb trough (temperature of -3°C. or less) and 850 mb thermal advection which slowly lowers the temperature to -3°C or less.

m. With a deepening Hatteras Low (B_1), start the snow when the low is opposite ORF. Forecast 5X½S Inter 3X3/8S - rate is about 4"/12 hours. When the center is between ORF and BOS, leave the moderate snow in the forecast. When north of BOS forecast 8-10OVC1-2S Inter 5X½S - rate is about 2"/12 hours.

n. When a Type E storm is west of 75°W and 850 mb temperature is -3°C or less at ALB, forecast the same as for Type B_1. When east of 75°W. treat like B_1 north of Boston. The snow will continue for 18 hours. Rate is 2 to 3"/12 hours.

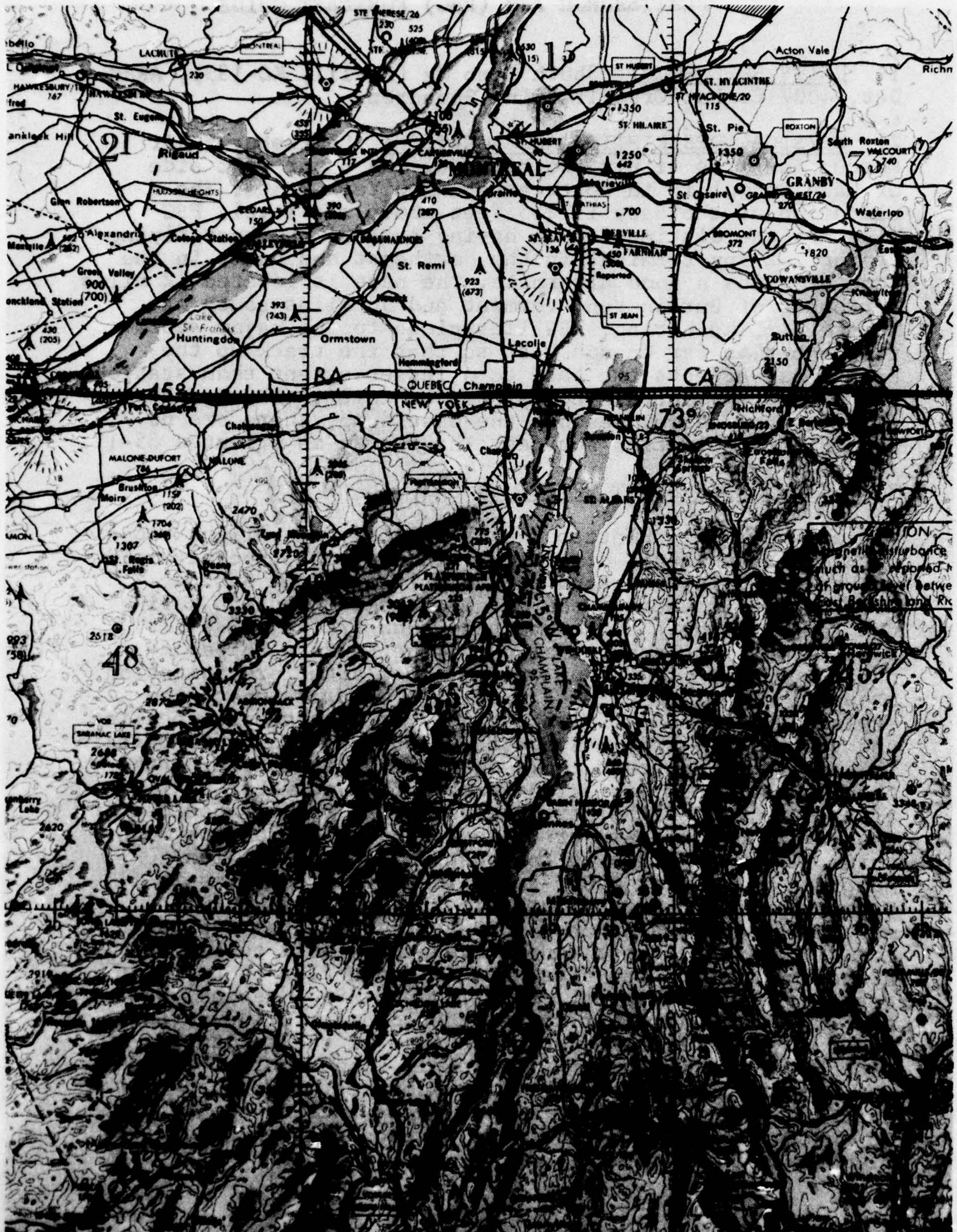
PLATTSBURGH AFB (PBG) FORECAST GUIDE

1. UNITS SUPPORTED: 380th Bomb Wg (FB-111, KC-135), ARRS Det, 4007 Combat Crew Training Squadron.

2. PHYSICAL DESCRIPTION AND LOCATION: Plattsburgh Air Force Base lies within two miles of the upper west side of Lake Champlain in northeastern New York State. The elevation of the base is 245 feet above sea level. PBG also has the distinction of having some of the best flying weather of any terminal in the Northeast and hence in the mean provides a good alternate. The base is located 22 miles northwest of Burlington, Vermont and 50 miles south of Montreal. Like Loring, PBG lies close to the major storm tracks but is far enough west so that the track up the East Coast affects the base to a lesser extent than stations further south. Terrain plays a major role in PBG weather as described below. Besides the base dump, there are no significant pollution sources. The runway is oriented 35-17.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Plattsburgh is located on a slight ridge with drainage in all directions. In addition, the airfield proper is built on a sand bar deposited by the Saranac River where it entered the original Lake Champlain during the last Ice Age. Rain or melting snow drains and sinks rapidly into the subsoil allowing the surface to become relatively dry within one or two hours after precipitation stops. These micro effects must have a large impact to explain the absence of long periods of observed low ceiling and visibility. From a synoptic viewpoint, the macro-terrain is also very important. Lake Champlain lies to the north through southeast, is a long narrow body of water and apparently has only minor effects on PBG weather because of the very short over-water trajectory. The Adirondack Mountains lie 20-30 miles to the west and southwest with numerous peaks over 4,000 feet. The Green Mountains in Vermont oriented north-south lie 25-40 miles away with maximum elevations around 4,000 feet. Due to an apparent lee side effect, these ranges frequently hold ceilings above the mean in the area when in-depth flow is from the east, south or southwest. (Ceilings at MSS (Massena) and ART (Watertown) are apt to be much lower). To the north about 30 miles lies the southern edge of the relatively flat broad St. Lawrence Valley. This topographical makeup channels the winds from the west-southwest and south-southeast quadrants to such an extent that winds of greater than 10 knots frequently blow across surface isobars at angles from 60 to 90 degrees.



LACHUTE
Acton Vale
ST. HYACINTHE
St. Eugene
St. Pie
ST. HILAIRE
1350
1250
ROXTON
South Roxton
GRANBY
Waterloo
21
15
33
Rigaud
Glen Robertson
Alexandria
Green Valley
900
(700)
HUDSON HEIGHTS
CEDARS
ST MATHIAS
IBERVILLE
FARNHAM
BROMONT
372
1820
COWANSVILLE
St. Remi
Huntingdon
Ormstown
Lacolle
ST JEAN
Sutton
2150
Hemmingford
BA
CA
QUEBEC
NEW YORK
Champlain
73°
MALONE-DUFORT
MALONE
Brushton
2470
1307
3330
2518
48
SARANAC LAKE
2620

Lake Champlain poses some problem when a low level easterly flow occurs (relatively rare). This effect is especially noticed in the early spring and fall when land-water temperature differentials are greatest. Presumably, the lighter the flow, the greater the effect since an air parcel would remain over the water longer and not be mixed out as the result of turbulence.

The effects of air masses from source regions cP, mP, and mT are about the same in the large scale as for Loring. Because of the orientation of the Hudson Valley and the more southerly latitude, PBG is under the influence of mT air more in the summer months than LIZ.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: (See also Introduction to synoptic types and regional discussion).

WINTER

a. Type B: Great Lakes low center goes up St. Lawrence.

(1) Clouds: D category ceilings 2-4 hours ahead of occluded front deteriorating to B in snow, C in rain for 4-6 hours. Broken C category ceilings will gradually lift to D until upper trough passes.

(2) Visibility: Haze restrictions in D category are possible with approach of system. B category in snow, C category in rain. Unrestricted after precipitation stops.

(3) Precipitation: Pre-frontal precipitation not likely until two hours before passage but lasts after passage for some time depending in strength of cold air advection. One to three inches of snow possibly mixed with freezing precipitation are likely.

(4) Winds: SE 15-25 unless strong low-level inversion exists. Shifts to NW 15-30 and subsides when low center reaches the Gulf of St. Lawrence.

b. Type B_1:

(1) Clouds: E or D category middle clouds increase as low moves up the coast. Deterioration to B category begins when low reaches point opposite New York City and continues until the low passes 45°N. Improvement to E category may be expected as wind shifts to NW within one hour.

(2) Visibility: Unrestricted until snow begins, then to A or B category depending on intensity of snow. Rapid improvement after wind backs to NW.

(3) Precipitation: Totally dependent on track of storm. See Section 5 - Seasonal Forecast Rules.

(4) Winds: N-NE 5-10 increasing to 20-35 again depending on proximity to PBG. Winds back to NW 20-30.

c. Type B_2:

(Clouds not significant, visibility unrestricted, no precipitation and winds N 5-10)

d. Type C:

(Jet South of PBG)

(1) Clouds: If gradient is weak, expect B category stratus deteriorating to A category in drizzle or light snow as waves move along front. Condition may persist for days. With stronger gradient, expect B or C category with occasional A category.

(2) Visibility: B category with occasional A category.

(3) Precipitation: Light snow or mixed. Rain not too common but drizzle possible.

(4) Winds: ENE 5-10. Stronger gradient may cause 15 kt.

(Jet North of PBG)

(1) Clouds: Broken middle clouds. D category if front is within 50 miles of station. Clouds increase with waves.

(2) Visibility: Unrestricted.

(3) Precipitation: None (4) Winds: Variable 5-10

e. Type D:

(1) Clouds: None at first with increasing cirrus as low moves into the Great Lakes. Weak warm front overrunning may occur if storm track is a little further east. If so, treat like Type C. Eventually the cold front will struggle through the area. Treat frontal weather like type B.

(2) Visibility: Unrestricted until cold or occluded front arrives, then category C with precipitation.

(3) Precipitation: None until front is close and then only in form of rain possibly changing snow flurries.

(4) Winds: Variable 5-10.

f. Type E:

No secondary low formation on East Coast

(1) Clouds: Clouds will be category E at first deteriorating to C when precipitation starts. Ceiling will rise to high D or E in the warm sector before occlusion passes. Clouds will go down to C or B category as the front passes.

(2) Visibility: Six miles in haze to C category in precipitation; lower if snow occurs. Rapid improvement after occlusion passes.

(3) Precipitation: Snow will generally begin when

system reaches southeast Ohio; changing to freezing rain prior to warm front passage.

(4) Winds: ESE 5-10 increasing as front approaches, shifting to SSE 10-20. Shift of wind behind occlusion will be slight until either secondary cold front or upper trough passes.

Secondary low forms along East Coast or low charges right through Pennslyvania and into central New England. Weather is the same in either case.

(1) Ceilings gradually deteriorate to B category as snow begins. If the low moves into central New England, the ceiling will be intermittently A.

(2) Visibility: Unrestricted until snow starts. B category for light to moderate snow; A for heavy snow. Short periods of fog follow cessation of precipitation.

(3) Precipitation: In either case, the low center gets so messed up that unless the majority of it goes N of the St. Lawrence, the advection of warm air is too weak this far north to cause any rain. Snow is heavy - rate of about 3" per 12 hours. May provide heaviest falls of the season.

(4) SE 5-15 increasing to 10-25 from NE; gradually backing to NW as low moves into the Maritimes.

g. Type E_s:

(1) Clouds: Forecast E until 4 hours prior to frontal passage, then C category ceilings prior and during frontal passage. C or low category D stratocumulus will persist well into the cold mP air and end quickly four hours after passage of a secondary cP or cA front. B ceilings and moderate SNSH may accompany the secondary front.

(2) Visibility: Unrestricted except in snowshowers.

(3) Precipitation: Light snow or rainshowers with mP front (use thickness to determine type). Snowshowers with secondary front.

(4) Winds: SE 10-15 shifting to WNW 15-25; then NW 10-20 with higher gusts accompanying secondary front.

SUMMER

a. Type B:

(1) Clouds: D category ceilings ahead of front and 4-6 hours after passage. If low center is in the St. Lawrence, treat like a winter system.

(2) Visibility: Unrestricted except during showers.

(3) Precipitation: Thunderstorms frequently occur up to 12 hours ahead of a cold front. Showers are generally light with passage, but expanded area of precipitation likely if system is sluggish or occluded. Summer B Type fronts can have more precipitation than the winter type.

(4) Winds: SE 10-20 shifting to NW 10-20; then falling off rapidly.

b. Type B_3: Only a problem if the front stretches across the Northeast (that is north of the Maryland border). Treat like a C winter pattern if the front in north of PHL.

c. Type X:

(1) Clouds: A few hours of broken stratocumulus then clearing. Watch out for the backdoor cold front returning as a warm front.

(2) Visibility: Unrestricted.

(3) Precipitation: None (4) Winds: SE-S 5-10 shifting to NE 10-15; then slowly veering to SE.

5. SEASONAL FORECAST RULES:

WINTER

a. Forecasting depth of snowfall with B_1 or secondary E types.

(1) Low through central New England combines with secondary developing off East Coast (rare) - 12 inches.

(2) Low tracks from Hatteras to eastern Maine - 6 inches.

(3) Track is across Nantucket - 2 inches or less.

b. Forecasting depth of snow/type of precipitation when Type E low tracks differently than classical movement up the St. Lawrence Valley.

(1) Track from central Pennslyvania through central New England with low center remaining south of PBG - 8 to 10 in.

(2) Track south of Pennslyvania with no recurving once off the East Coast - gutter snow.

(3) Up the St. Lawrence with weak warm air advection pattern - snow showers changing to light freezing precip.

c. To get freezing precipitation at PBG, strong warm air advection must persist for 12 hours or more over a surface cold pocket. (In b(3) above, the advection has occurred over a long period of time -several days).

d. 850 mb temperatures as low as -3°C. can produce freezing

precipitation when warmer air is present between the 850 mb and 700 mb levels.

e. Consider 1,000-500 mb thickness values between 5,340 and 5580 meters for freezing precipitation.

f. The best time for low D category ceilings occurs between 1200L and 1800L when there is northwesterly flow at 850 Mb and cold air advection is taking place.

g. Light northeasterly winds when PBG is in a frontal area or a moist air mass is present (C and E types especially) will produce B category ceilings and frequently extended periods of A. A slight wind shift to the NW will rapidly improve the ceiling to C.

h. During the winter months when a surface trough is located behind a north-south oriented cold front, forecast ceilings in low D category ahead of the front dropping to C behind the system and clearinh shortly after the trough passes (Types E_s).

i. Snow moves rapidly into the PBG area after starting in New York City (4-6 hours later). Expect an early start time if an inverted trough extends north of the low itself.

j. Great Lakes Lows: (Type B, E_s in some cases) These will produce three inches or more snow if their track is up the St. Lawrence Valley just north of the area. Systems to the south of PBG can produce freezing precipitation. If the low center is well to the north, precipitation is negligible.

k. Clearing can be expected from Hatteras Lows when they pass north of 45°N.

l. Ceiling will drop to B category as soon as the snow starts with A category in heavy snow.

m. Surface winds with gusts greater than 35 knots can be expected with the passage of a strong cold front associated with strong northwesterly winds behind the front.

SUMMER

a. During the spring, summer and fall, PBG can expect clearing when an east-west cold front moves south to the Albany area. (Type C, X, B_3 when front is quite far north).

b. During the summer when PBG is under the influence of steady southerly flow of moist mT air persisting for two days or more, the visibility will drop to C category during the day and high D or E category at night. If the condition persists for 3-4 days, B category visibility is possible.

c. Type B: Frontal thunderstorms can be expected two to three hours prior to frontal passage. The activity will decrease rapidly behind the front unless there is a strong trough following.

d. Thunderstorms with ½" hail or winds greater than 35 knots are rare at PBG (three cases of pea size hail in the last eight years).

LORING AFB (LIZ) FORECAST GUIDE

1. UNITS SUPPORTED: Bomb Sq Two tanker Squadrons. Additional amendment criteria of 300 feet and/or 1 mile.

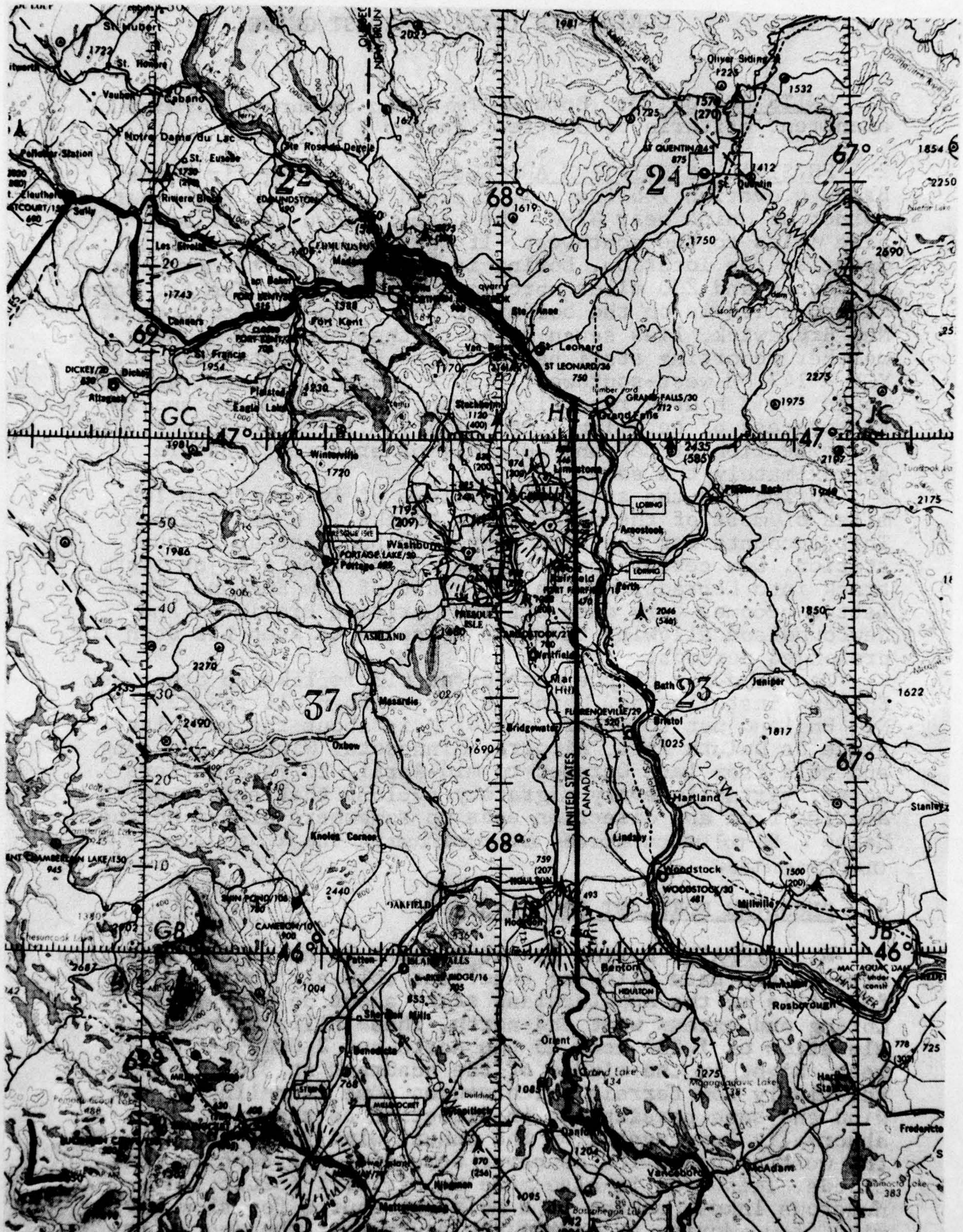
2. PHYSICAL DESCRIPTION AND LOCATION: Loring Air Force Base, elevation 746 feet, is located in the far northeast corner of Maine near 47°N. The nearest town is Caribou nine miles to the southwest. If that does not adequately describe the location, Loring is 280 miles north-northeast of Boston and 230 miles northeast of Montreal. The St. Johns River, which is on the border of Maine and the Province of New Brunswick, lies seven miles to the east. The closest weather reporting stations are YRI - 84 NM west-northwest, YQB - 147 NM west-southwest, YSC - 183 NM southwest and 6B2 (open for 3 hourly reporting during daylight hours and in the process of becoming automatic) at 112 NM southwest. With the exception of CAR and HUL, all other directions are approximately the same.

Loring has the special privilege of lying within 100 miles of most of the major storm tracks in North America. This accounts for the high degree of bad weather at the station. Low centers pass to the north along a major storm track into Labrador and up the coast of New England. The latter becomes very deep off the Maritime Provinces and Newfoundland allowing backside moisture to keep LIZ down for prolonged periods.

The behavior of the weather at LIZ is like no other New England installation. Maine is larger than all the rest of New England put together, and 47°N is about the same latitude as Duluth Intl. Airport, Minnesota. Winters are long and cold from late October to mid-April. To make matters worse, virtually every migratory cyclone that enters North America from any direction ends up somewhere around northern Maine. No pollution sources are significant. The runway is 35-17 or 01-19 magnetic.

3. PECULIAR FORECAST PROBLEMS:

a. TERRAIN: Loring is the highest point in the immediate area of the base allowing excellent cold air drainage. The foothills of the Appalachians start about 35 miles west of Loring and extend west and north. These hills have a mean elevation of 1,500 feet to the north and 2,000 feet to the west. Right in the middle of the quadrant at 310° is some relatively low terrain which causes some funneling of the wind and some persistence in direction as shown by the abnormally long vector on the annual wind rose. The hills to the west although low do cause some drying effect on low clouds. This area is also made up of thick forest and numerous lakes, making it a moisture source for slow moving wind flow. Moving around to the southwest, the foothills



St. Hubert
St. Honoré
Cabano
Notre Dame du Lac
St. Eusebe
Ste Rose-du-Degelé
Pelletier Station
Riviere Bleue
Les Etroits
Connors
St. Francis
Fort Kent
Dickey
Allagash
Eagle Lake
Plaisted
Van Buren
St. Leonard
ST LEONARD/36
GRAND FALLS/30
Grand Falls
St. Quentin
Oliver Siding
Ste. Anne
Wintervill
Washburn
PORTAGE LAKE/30
Limestone
Aroostook
Fairfield
Perth
PRESQUE ISLE
ASHLAND
Masardis
Oxbow
Knowles Corner
Mars Hill
Bridgewater
Bath
Bristol
Juniper
Hartland
Woodstock
WOODSTOCK/30
Millville
UNITED STATES
CANADA
HOULTON
Houlton
OAKFIELD
Patten
ISLAND FALLS
Sherman Mills
Benedicta
Benton
Orient
Rosborough
Danforth
Vanceboro
McAdam
Fredericton
Stanley
CHAMBERLAIN LAKE/150
GC
HC
JC
GB
HB
JB
47°
46°
67°
68°
69°
22
24
37
23

rise much more rapidly with numerous peaks in northern New Hampshire over 4,000 feet. Mt. Washington (6,288) is 215 miles from Loring, and on the same radial lies Mt. Katahdin (5,273) 78 miles from the base. Moisture sources abound in this direction also, but the downslope motion is even greater than to the northwest especially on systems moving from the west which are embedded in southwest flow aloft. The south quadrant, which also shows a maximum on the annual wind rose, is a real problem direction. It is upslope moving from the ocean all the way to Loring, aided by all sorts of lakes and ponds. Fog and stratus which form over the ocean are advected up the St. John River Valley which makes up the eastern boundary of Maine (for the most part). The stations which will give the best indication of this condition are Eastport (synoptic 608) and HUL (airways). HUL will usually be the best indication of this northward movement, but occasionally this is not so as the fog and stratus will move up the valleys below them. Hence, this direction is a favorite path for fog and upslope stratus year around. Another range of hills lies over in New Brunswick across the river from southeast through north-northwest. These hills start about 30 miles to the east, running about 25 miles south and 40 miles north. The range averages about 30 miles wide, averages about 1,500 feet and contains a high elevation (2,690) 50 miles to the northeast. There is a drying effect (for the most part), and low clouds and precipitation tend to be retarded when flow in depth is moving from the east. It could be said that the easterly quadrant has the shortest and least significant water trajectory. However, in the broad sense, two bodies of water have a profound influence on the weather locally; the Bay of Fundy (120 miles southeast) and the Gulf of St. Lawrence (120 miles east and northeast). The St. Lawrence River, which is about 90 miles north and northwest of the base, exerts much less effect but helps the modification process (warming and addition of moisture) of the cP highs moving out of Canada. Although Loring is located higher than its immediate surroundings; it can be said that Loring is at the bottom of a dish, a very significant fact during the winter. Warm advection over a cold snow cover is common from the south preceding systems moving up the west side of the Appalachians into the St. Lawrence River. Fog, stratus and conditions conducive to freezing precipitation result (especially the periods late November through mid-January and early March through mid-April). Fog and stratus become trapped in the cold air trapped in the dish by the mountains surrounding Loring. Even active fronts will not break this situation, but usually several hours after a west to east frontal passage, cold dry advection will occur from the northwest. Until the cool dry air is well established in the area, no real improvement can be expected.

b. Air Masses: It is never really warm at LIZ during the winter, but there are several days each month that the temperature reaches near freezing resulting in some melting of the snow cover. mT air rarely reaches Loring except in a strongly amplified Type E case when a deep low stagnates in eastern Canada. A very modified mT air mass will reach the Loring area with almost any flow from the southwest or southeast. Under most conditions, Loring is in the grip of cP or cA air which is modified somewhat but much less than for stations to the south. cP air can become somewhat unstable as it approaches Loring, and one can look for some scattered snow shower activity. mT is most common in the summer along with the southerly winds which make the base susceptible to early morning fog which lifts into stratus. Near the point of maximum afternoon heating, slow moving and short life cycle air mass thunderstorms occur (less vigorous than any other station in the U.S.). From the experience of many forecasters, they are like European thunderstorms. The displacement of the mT air mass by cP air is a frequent occurrence in the summer.

c. Fronts: Because of the high latitude, most north-south oriented fronts pass as occlusions with Type B cold occlusions and Type E warm occlusions. Because of the nature of moisture advection with north-south oriented fronts, weather is bad with both types, unlike stations further south which experience less weather with Type B. LIZ is closer to the center of action and stronger vertical motion fields. Fronts with southwest-northeast, east-west or northwest-southeast orientations are extremely difficult to time (Types C, E_s, and X) with the terrain tending to hang these up in the St. Lawrence Valley. However, a moving system with this orientation produces less weather than a north-south system. Type C polar jet is rarely found north of LIZ, so with prolonged easterly flow, the flying weather is apt to get quite bad after a while. All fronts of the Type B, C and E look like warm fronts by the weather observed at LIZ, although analysis as such is almost impossible.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: (See also Introduction and Region 7 Synoptic Discussion)

a. Type B: Low center in St. Lawrence Valley.

(1) Clouds: Forecast D ceilings 6-8 hours in advance of the front lowering to B in snow for 4-8 hours. Conditions should return to E in 6-8 more hours. Periodicity of 2-3 days between systems. Prefrontal stratus/fog not likely.

(2) Visibility: Unrestricted except B or C category in snow.

(3) Precipitation: 1-2 inches of snow unless central pressure of low less than 1,000 mb, then expect 2-5. (8 hours)

(4) Winds: S 10-20 shifting to NW 10-15 behind front. WNW 20-30 if low is quite deep.

b. Type B_1:

(1) Assume track is southeast of Nantucket to south of Nova Scotia.

(a) Clouds: Layered high middle clouds (E or high D).

(b) Visibility: Unrestricted.

(c) Precipitation: Very light snow showers possible as low crosses 42°N until it reaches 47°N - trace accumulation. Up to 12 inches if the track changes to go up the Bay of Fundy (rare).

(d) Winds: N-NNE 5-10 increasing to NW 10-20 as low moves up coast.

(2) Assume low has strong oval shape oriented northeast to southwest; same track.

(a) Clouds: Same as above but increased stratocumulus in C category, then to B as northeast flow in depth continues. Low ceilings begin when low passes 43°N and persists until the easterly component is removed.

(b) Visibility: C category in snow showers; unrestricted otherwise. In summer, B category in drizzle and fog.

(c) Precipitation: Only light snow or snow showers unless track of low is to the left, closer to the Maine coast. In summer, light rain or drizzle.

(d) Winds: NE-N 5-10 increasing to 10-20, backing as above but may take 24-48 hours.

c. Type B_2, D: Type D regime eventually has a front moving sluggishly through New England. Treat like weak Type B.

d. Type C: Polar jet is always south of Loring. (This type)

(1) Clouds: Multilayered up to 12,000 feet. Prolonged east-northeast trajectory produces category B, occasionally A ceilings after 10 hours. Waves on front produce tops to 25,000 feet. Regime may last for days.

(2) Visibility: C or D category in snow showers; perhaps lower with stronger wave moving through New England.

(3) Precipitation: Light snow showers may increase with waves; rarely over two inches total in 24 hours.

(4) Winds: ENE 5-10 increasing to 10-15 at times.

e. Type E: No lee side formation of secondary.

(1) Clouds: Warm front overrunning configuration:

D category to B category with start of precipitation, as low moves into northeast Ohio. A category likely at times. Improvement to C unlikely at all until system reaches Labrador.

(2) Visibility: Rapid deterioration with increased overrunning. Prefrontal fog is definite possibility.

(3) Precipitation: Light to moderate snow. May change to freezing rain or rain if low stalls in upper St. Lawrence Valley allowing prolonged southerly flow over Maine. If track of cyclone is across Great Lakes (further east than Type D), the eastward progression of precipitation is much slower and will likely be rain. (Strong warm air advection)

(4) Winds: S 5-10 increasing to 15-20 as low moves into St. Lawrence. Winds will not shift rapidly.

SUMMER

a. Type B_3: No significant weather unless the front lies in central or southern New England - then treat like a winter C pattern.

b. Type B:

(1) Clouds: D category in showers. (2) Visibility: Category D in showers. (3) Precipitation: Light unless moisture advection has persisted for several days prior to the front. (4) Winds: S 5-15 shifting to N 10-15.

c. Type X:

(1) Clouds: C category at passage improving rapidly.

(2) Visibility: Unrestricted (3) Precipitation: None

(4) Winds: S 5-15 shifting to N 10-15, then variable

5. SEASONAL FORECAST RULES:

WINTER:

a. If a coast low goes up the Bay of Fundy moving north, expect WWXX snow criteria to be met. (Total = 12 inches).

b. Expect the precipitation to be in the form of freezing rain or heavy snow when the system is strong. Rain will only occur if the low is north and stalled.

c. As lows wind up off the coast of Newfoundland or the east coast of the Maritimes (over the Gulf of St. Lawrence), watch for troughs coming around the back side producing C category ceilings and snowshowers. Look for cold air advection and cyclonic curvature through 700 mb. The cloudiness tends to break up at night.

d. Lows traveling south of the St. Lawrence River and into the Gulf of St. Lawrence can be expected to stagnate or decelerate and bring moist air from the Newfoundland area. Stratocumulus and showers will persist from 24 to 48 hours.

e. Radiation fog becomes most intense in November. Ground in the area is still damp before it becomes frozen by mid to late November.

f. The maximum surface wind gust will not usually exceed the CAR (712) 2,000 foot wind speed.

g. The maximum surface wind gust between 00Z and 12Z will rarely exceed 15 knots unless the surface gradient is intense.

h. Expect snow if 1,000-500 mb thickness is 5,340 meters or less; mixed or freezing precipitation 5,340 to 5,460 meters; and rain if thickness exceeds 5,460 meters.

i. Actual warm fronts rarely pass Loring, but features that analyze like warm fronts frequently pass.

j. After two hours of continuous steady precipitation, ceilings will be 1,000 feet or less; most commonly 700 feet lowering to 300 feet by 6 hours. (Works in summer also). Does not apply to showers.

k. When warm frontal fog is present at sunrise, no marked improvement should be expected before 1000L.

l. Ground fog is frequently observed in the surrounding areas but not near the runway.

SUMMER

a. Fog and stratus are a common occurrence in the summer (southerly wind predominates). Upslope advection brings fog at night after two to three days of southerly flow which lifts into stratus two hours after sunrise and into cumulus by afternoon.

b. The most common cases of the above occur when an anticyclone is stationary over Nova Scotia or off the coast of New England. (Also Type X). Wind speed makes very little difference to this type of fog.

c. If a strong inversion exists in the lower layers, strong gusting winds are not likely.

d. Frontal systems approaching Loring from the west or northwest often slow down considerably after passing east of the St. Lawrence River Valley.

(1) This deceleration frequently leads to rapid dissipation of thunderstorms within three hours after maximum heating.

(2) There is a marked reoccurrence of thunderstorms from mid-evening until near midnight.

e. Squall-lines are not a common occurrence at Loring.

f. After the second day of southerly flow, expect short-life cycle air mass thunderstorms moving very slowly in the vicinity of Loring.

(1) These usually develop over the higher terrain to the south and southwest of the base.

(2) Thunderstorms are usually in the dissipating stage when they reach Loring.

(3) Loring experiences on the average <u>one</u> moderate or greater thunderstorm per year. Classical rules on severe thunderstorms have <u>little</u> application at Loring!

PEASE AFB (PSM) FORECAST GUIDE

1. UNITS SUPPORTED: 509th Bomb Wg, 2 Tanker wings, NHANG, (C-130), Hanscom CL. Additional amendment criteria of 500 feet and/or 1 mile.

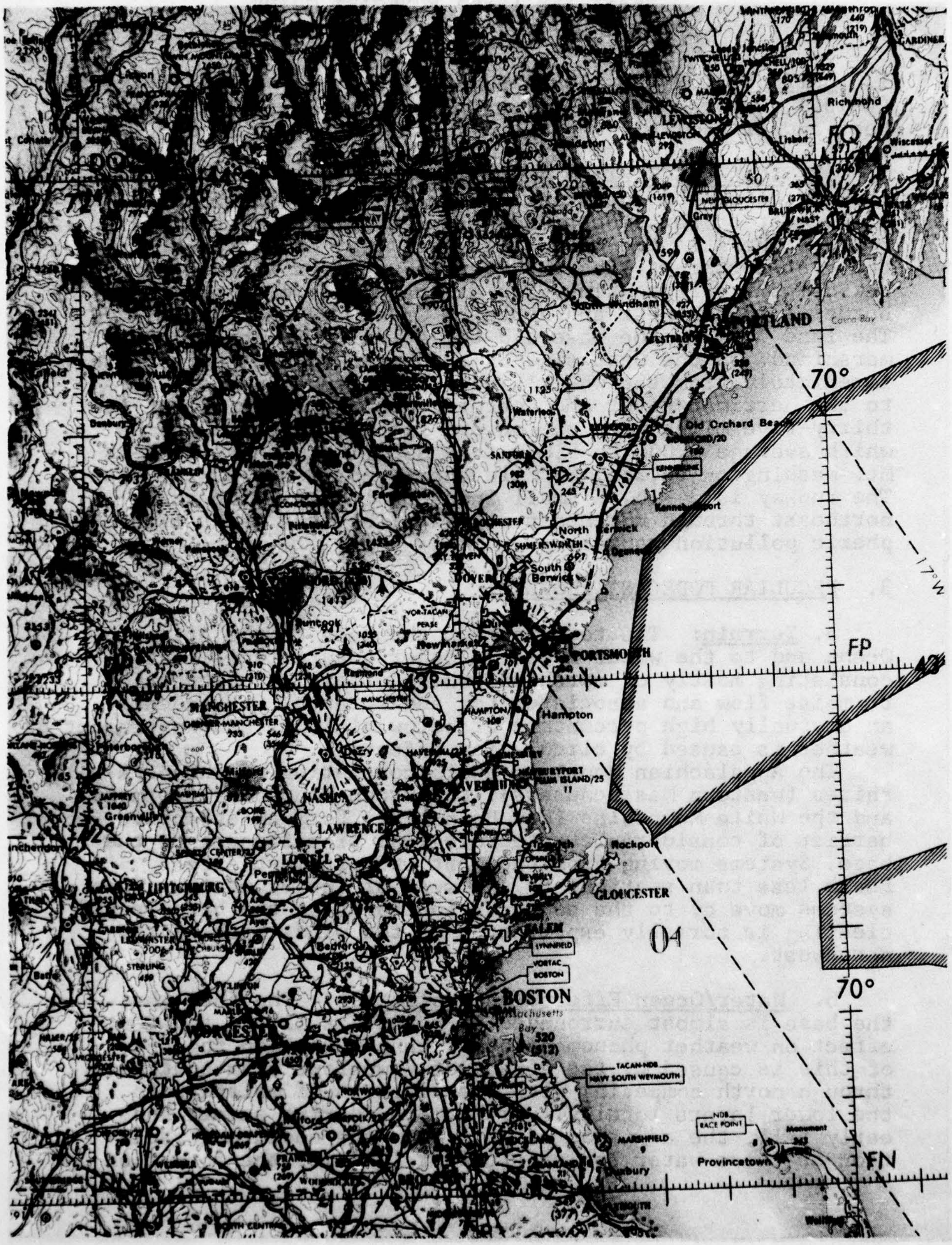
2. PHYSICAL DESCRIPTION AND LOCATION: Pease Air Force Base is located on the southeast coast of New Hampshire three miles west of Portsmouth and 48 miles north-northeast of Boston. The Atlantic Ocean lies just east of Portsmouth. To the east-northeast lies the Piscataqua River which separates New Hampshire from Maine. The air base lies on a peninsula bordered to the west and north by Great Bay and Little Bay. The land between the base and the Atlantic Ocean is mostly marshland. On the west side of the bays, rolling hills rise immediately from the water's edge and then slope downward to the Merrimac River and Concord, New Hampshire. Twenty to thirty-five miles west of Concord lie the White Mountains which average 3,000 to 5,000 feet MSL. The highest peak is Mt. Washington (6,288) 85 miles north-northwest of the base. The runway is 34-16. A small industrial area lying east-northeast through northeast at two miles is a major atmospheric pollution source.

3. PECULIAR FORECAST PROBLEM:

a. Terrain: The terrain from the base to the Atlantic Ocean and to the water areas in other quadrants is flat, consisting mostly of marshland which offers no obstruction to moist flow and associated fog and stratus. Consequently, an unusually high percentage of below minimums and instrument weather is caused by circulation effects.

The Appalachian Mountain chain consisting of the Berkshires (western Massachusets), the Green Mountains (Vermont) and the White Mountains (New Hampshire) form an effective barrier of considerable meteorological significance to the base. Systems moving from the west or northwest affect Pease less than stations to the west of the mountains. When systems move by to the south or southeast of the base, rapid clearing is normally experienced as the winds back to the northwest.

b. Water/Ocean Effects and Pollution: The fact that the base is almost surrounded by water has little apparent effect on weather phenomena other than radiation fog. Part of this is caused by the effect of downslope from southwest through north competing with the addition of moisture to the lower layers locally. Furthermore, during summer and early fall, the addition of heat from the nocturnal radiation of these water bodies slows or inhibits the formation



PORTLAND
Casco Bay
Richmond
Lisbon
Gray
NEW GLOUCESTER
South Windham
Waterloo
Old Orchard Beach
KENNEBUNK
SANFORD
North Berwick
SOMERSWORTH
South Berwick
DOVER
PEASE
Newmarket
PORTSMOUTH
MANCHESTER
Hampton
NASHUA
LAWRENCE
Greenville
Rockport
GLOUCESTER
SALEM
LYNNFIELD
VORTAC
BOSTON
Massachusetts Bay
TACAN-NDB
NAVY SOUTH WEYMOUTH
NDB
RACE POINT
MARSHFIELD
Provincetown
Duxbury
STERLING
LEOMINSTER
70°
17°W
FP
FN
18
04

of radiation fog (See section 5).

The ocean itself is a major polluter in that large quantities of salt nuclei exist in the lower atmosphere when the flow is off the water. These nuclei are the proper dimension for increased condensation and contribute greatly to increased incidence of fog, stratus and haze. To some extent, this is also dependent on water temperatures. Along the eastern seaboard south and east of Cape Cod, ocean temperatures are dependent upon the warming effects of the Gulf Stream. North of Cape Cod, they are a result of the less massive but significant cold Labrador Current. This stream parallels the coastline southward along the Canadian Maritime Provinces into the Gulf of Maine. The cold wall, which is the transition zone between the two currents is quite narrow, only a few hundred miles wide, and its location is fairly constant throughout the year. A trajectory of warm air over cold water results in fog and stratus which without improvement in the synoptic situation will cause prolonged near or below minimum conditions when it moves onshore.

Industrial pollution such as that mentioned in Section 2 above will aggravate stratus/fog conditions due to large quantities of smoke which may produce bands of drizzle , especially in the approach zone to runway 16 (with ENE to NE flow). There are also enormous industrial pollution sources in Lowell, Lawrence and Boston to the south. With sustained southerly flow, haze conditions may produce visibility less than three miles.

c. <u>Transient Controls</u>: A slow-moving cP air mass will modify as it stagnates off the coast of the Canadian northeast and will take on similar characteristics of the Pacific High if the pattern lasts long enough. Air flowing around the bottom side picks up moisture off the cold water so that the lowest layers resemble an mP air mass. Marked subsidence above a 3,000 foot or so inversion with anti-cyclonic curvature insures the maintainence of a poor weather regime.

d. <u>Fronts</u>: Cold fronts are most common during the spring through fall with normal short durations of cloudiness and showery precipitation. Thunderstorms and occasional squall-lines may precede the front, but tornadoes and hail are <u>very</u> rare.

Warm frontal passages are uncommon. The initial orientation of these fronts is generally west to east through the central Atlantic Seaboard. The cold water off the east coast of New England intensifies the overlying ridge and produces a shallow but persistent wedge of cold air which is usually replaced by the warmer air only when the southerly gradient exceeds 30 knots. The warm front more often moves to southern New England, then stalls while an occlusion moves through New England from the west. Near or

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FORECAST GUIDES USED FOR THE CENTRALIZED TERMINAL FORECAST PROG--ETC(U)
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4 OF 6
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below minimum conditions can be expected, especially in the absence of rain, until either the occlusion or warm front move through the terminal area. Circulation effects from more or less stationary warm fronts south or southwest of Pease are responsible for sustained periods of low ceilings, visibility, precipitation and fog. The ideal situation for this is development of a stationary ridge oriented north to south off the East Coast. This ridge will permit overrunning yet prevent the formation of a secondary low along the mid-Atlantic coast. The resultant onshore flow combined with air mass overrunning will produce steady precipitation, fog and stratus which will sometimes last over 48 hours. When the ridge breaks down, splits or moves east, the secondary low has a chance to develop and move northeast along the coast. As with all circulation effects, rapid improvement will occur when surface winds back to a northwesterly direction.

The frequency of occluded frontal passages is second to the cold front type. Associated weather conditions are similar to the warm frontal type as the two fronts usually coexist. In the absence of a warm front, the weather events are similar to those experienced with a cold front except that it is usually not associated with vigorous gradients, winds, etc. It is also more likely to stagnate or dissipate as it moves across the northern Appalachians. Since there is less change in air masses as the front passes, stratocumulus ceilings may develop as the result of surface heating, cold air advection aloft and cyclonic curvature. This is a daytime phenomemon, and clearing skies can be expected toward sunset. The resulting instability may be sufficient to set off some air mass thunderstorms during late afternoon. During winter, smow showers would occur instead. In general, post-frontal improvement is most rapid during winter when the systems with which the fronts are associated are more vigorous, and subsequent air masses are far drier.

As long as a northwesterly flow of air is maintained over New England, favorable ceiling and visibility conditions can be expected. The orographic effects of the Appalachian Mountains and lake effect from the Great Lakes cause considerable cloud cover and frequent shower activity on the windward slopes. Generally only a combination of strong gradient, instability and moisture will carry these conditions into the coastal plain, and even then they are greatly modofied. Ceiling heights will normally be in excess of 3,000 feet, and precipitation is rare. Clearing can be expected before sunset.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type discussion in the Introduction.

a. Types B, B_1, B_2, D, and E_s: (See AYE Forecast Guide)

b. Type C:

(1) Case 1 - Polar jet south of PSM: The cloud cover comes in sooner and leaves later as trajectory is right off the water. B category occasionally A for both ceiling and visibility. If heavier precipitation occurs, do not expect ceilings to lift. Freezing drizzle or rain likely.

(2) Case 2 - Polar jet north of PSM: The flow pattern is much more critical than at AYE. Southeast through south flow will produce B category stratus in the morning rising to C category in the afternoon. The visibility is improved primarily because the restrictions are due to salt haze and pollution.

c. Type E: The low clouds and visibility may deteriorate much more quickly than at AYE. A or B category will probably be experienced with or without precipitation of any intensity as long as the flow is off the water to the east and southeast.

SUMMER

a. Type B_3: The low stratus and fog will rapidly appear as soon as the flow turns to off the water. Instability showers may not wipe out the inversion, and therefore do not bring up the ceiling during precipitation necessarily.

b. Type X: PSM is likely to deteriorate to B category with every back door cold front as long as the flow turns east. On occasion, a northwest wind will occur, and low ceilings and visibility will not occur until a shift toward the water takes place.

5. SEASONAL FORECAST RULES:

a. Precipitation in the winter will probably always tend to be rain at PSM if it rains at AYE, but owing to the critical nature of isotherm packing, the fact that PSM lies further north will cause freezing precipitation to continue for a longer period.

b. Lowering of ceiling in precipitation: (1) Multiply the forecast surface $T-T_d$ at the time rain is going to begin by .65 (5 degrees X .65 = 3.05 hours) or (2) Add three hours to the beginning of the rain to forecast a ceiling falling below 1,500 feet.

c. To forecast the maximum gust from the northwest associated with a cyclone to the east or northeast, use the pressure differential between BTV-BGR. The following shows the gust:

BTV-BGR	GUST
5 mb	18 knots
10 mb	28 knots
15 mb	40 knots

d. If the 850 mb temperature is -2°C. or lower, any precipitation will be solid.

e. After a cold front passage, stratocumulus ceilings will form until 700 mb trough is east of the area. The chances of ceilings are further increased if the 500 mb level center is closed.

FORT DEVENS (AYE) FORECAST GUIDE

1. UNITS SUPPORTED: 10th Special Forces (aviation det and parachute), 1st Army Readiness Region. Additional amendment criteria of 700 feet and/or 1 mile which are airfield minimums.

2. PHYSICAL DESCRIPTION AND LOCATION: Fort Devens is located 29 miles inland from the Atlantic Ocean (Revere Beach is due east) in northeast central Massachusets at an elevation of 268 feet above sea level. Bodies of water lie from 040 degrees to 230 degrees at varying distances; Massachusets Bay to the east, Narragansett Bay 55 miles to the south-southeast and Long Island Sound 90-160 miles south-southwest through southwest. Ft. Devens is located in the approximate center of the Nashua River Valley which at that point is about five miles across. North-south oriented ridgelines west and east of the base rise 400-500 feet. The Nashua River meanders through the valley and flows along the western edge of the runway. The valley is full of marshland and provides considerable moisture for radiation fog and daytime cumulus, especially after periods of heavy precipitation.

3. PECULIAR FORECAST PROBLEMS: (see also PSM)

a. Terrain: Starting from a point immediately to the west of Worcester (20 miles south-southwest of AYE), a range of small hills approximately 1,000 feet high extend in a north-south direction curving into New Hampshire and Maine. Further to the west lie the Berkshires and to the northwest and north the Green and White Mountains. These mountains act as a partial barrier to systems arriving from the west through north.

b. Pollution: Ft. Devens is located in an industrial environment with major sources to the west, southwest, east and northeast. This adds considerably to large scale stagnant air mass pollution.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Synoptic Type discussion in the Introduction.

WINTER

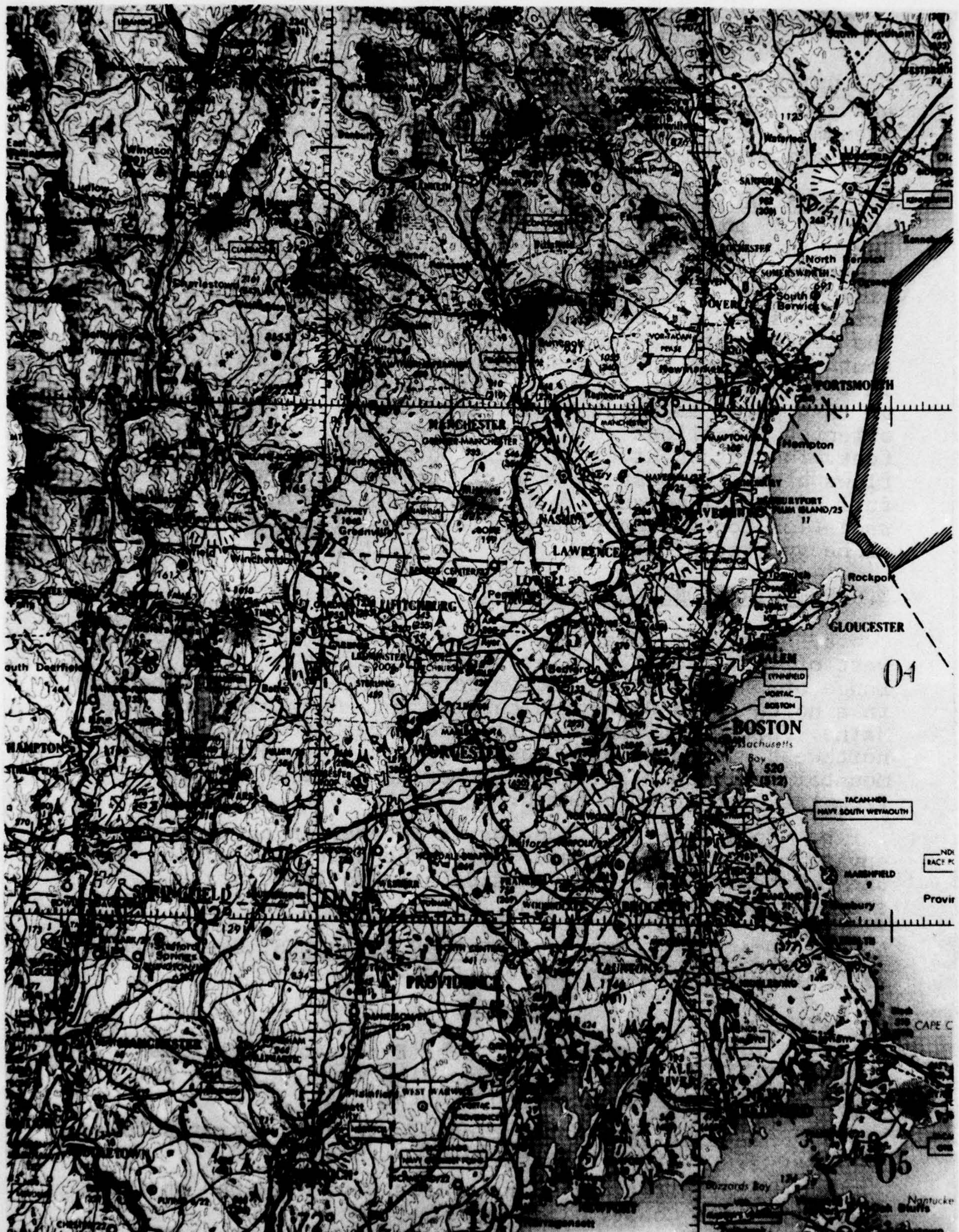
a. Type B:

(1) Clouds: Broken high D or E category ceilings with frontal passage. If Bermuda High is weak, look for possible low stratus prior to frontal passage.

(2) Visibility: Unrestricted unless low stratus forms. If it does, consider B category.

(3) Precipitation: None unless wave develops on front along the East Coast. (See Type B_1).

(4) S 5-10 shifting to westerly 10-15, falling off again after upper trough passage.


MANCHESTER
NASHUA
LAWRENCE
LOWELL
FITCHBURG
PORTSMOUTH
Hampton
North Berwick
South Berwick
Rockport
GLOUCESTER
BOSTON
WORCESTER
SPRINGFIELD
PROVIDENCE
Winchendon
Windsor
NAVY SOUTH WEYMOUTH
MARSHFIELD
CAPE C
Nantucke
Buzzards Bay

b. Type B_1: Low stays well offshore.

(1) Clouds: Broken high layered tops to 30,000 feet. Watch for returning C or D category stratocumulus if low gets very deep off maritime provinces.

(2) Visibility: Unrestricted except intermittent four miles in snow showers.

(3) Precipitation: Light snow showers generally accumulating less than one inch.

(4) Winds: NE 10 increasing somewhat as low passes east of Nantucket and gradually backing to NW 10-20. Again if the low deepens to the east of the Maritimes, the surface winds may increase to 15-30 knots.

Low track is close to East Coast

(1) Clouds: Layered clouds to 30,000 to start with raidly lowering bases with onset of precipitation. If rain forecast, expect high B category; snow forecast A or low B category. Ceilings will rapidly lift as surface winds back to the northwest. Broken cumulus likely the next day especially prior to passage of upper trough.

(2) Visibility: Unrestricted until precipitation begins; B category in snow, C in rain. Rapid improvement after precipitation begins.

(3) Precipitation: Light to moderate starting when low reaches 37°N and then becoming heavy as low reaches 39-40°N tapering off as winds back. Extensive snow shower activity after the principle low passes is not likely. Up to 40 inches of snow has been observed on occasion with this type.

(4) Winds: If there is a strong high over Quebec, expect winds to increase to 20-40 knots based on gradient. NW winds of 15-25 knots behind system likely.

c. Type B_2:

(1) Clouds: Scattered cirrus and altocumulus. If low manages to reach Newfoundland, it may explode with backwash of moisture producing D category ceilings locally (when you least expect it).

(2) Visibility: Unrestricted (3) Precipitation: None

(4) Winds: N 5-10; may increase if low deepens as above.

d. Type C: Polar jet south of AYE

(1) Clouds: Low stratus layered up to 8,000 feet with variable broken middle, high clouds above. B category unless

precipitation occurs - then A likely. Regime will not clear up until either jet moves north of station or a strong system passes aloft to shift wind to provide a westerly component.

(2) Visibility: B category can deteriorate to A.

(3) Precipitation: Drizzle or freezing drizzle quite likely especially with weak upper troughs moving through flow.

(4) Winds: ENE 5 knots, occasionally 10-15.

Jet north of AYE

(1) Clouds: Scattered to broken stratocumulus in the afternoon, broken C category morning (determined by trajectory of flow based on position of high cell offshore).

(2) Visibility: 5-7 miles in haze and smoke - possibly lower if inversion is strong.

(3) Precipitation: None

(4) Winds: SE-SW less than 5 at night; 5-15 during day.

e. Type D:

(1) Clouds: None. Late in regime, cold front will move sluggishly through New England. Treat like Type B system.

(2) Visibility: Unrestricted except 4-6 miles in smog due to local pollution sources (sunrise and sunset).

(3) Precipitation: None. Showers with front late in the regime.

(4) Winds: Variable mostly less than 10 knots.

f. Type E: Assuming no secondary low development on lee side of Appalachians.

(1) Clouds: Classical warm front configuration layered from less than 1,000 feet to 35,000 feet as system approaches. A long period of low ceilings precedes the system. Rapid improvement to high category C occurs with frontal passage to clear after upper trough passage.

(2) Visibility: C or D category in haze deteriorating rapidly to B in drizzle and then rain. May improve to C during periods of steady rain. Rapid improvement to unrestricted after frontal passage.

(3) Precipitation: Light rain or drizzle beginning when low reaches Ohio Valley gradually increasing in intensity until frontal passage. Moderate to heavy rain can be expected. If a cold high exists over New England when the

system gets developed to the south, the precipitation will begin as snow, then go through sleet and freezing rain before changing to all rain - little effect on ceiling or visibility.

(4) Winds: ESE to NW 5 increasing to 10-20 rapidly veering to SW 15-25 after passage. Winds fall off rapidly at nightfall or with passage of upper trough.

Note: If the low goes anywhere other than up the St. Lawrence Valley and/or if a secondary low forms east of the Appalachians, then an entirely different set of circumstances occurs. The main low may move through New England or up the coast as the Ohio Valley center dissipates in western New York State. Watch the situation very carefully as it develops.

g. Type E_s:

(1) Clouds: E or high D category middle clouds with frontal passage. Clouds persist as upper trough remains stationary.

(2) Visibility: Unrestricted.

(3) Precipitation: Light showers at times.

(4) Winds: S-SW 10-15 shifting to NW 10-15 with passage. Winds continue at that speed with diurnal decrease at night.

SUMMER

a. Type B:

(1) Clouds: Low stratus may precede, but this is usually broken up quickly in late morning by heating and increasing surface wind. Broken middle and high clouds accompany thunderstorm and squall-line activity. Clearing occurs behind front.

(2) Visibility: Restricted by haze and pollution in warm moist tropical air - generally D category. Rapid improvement after frontal passage.

(3) Precipitation: Showers 3-4 hours prior to front.

(4) Winds: S 10 increasing to 10-20. W-NW 10-15 behind front decreasing at night.

b. Type B_3:

(1) Clouds: Low stratus will develop as flow turns to the east-northeast or southeast producing relatively strong low-level inversion (B category). Waves moving along front are apt to wipe out inversion temporarily even if

precipitation occurs. Periods of broken middle cloudiness and thunderstorms with waves (C category in thunderstorms).

(2) __Visibility__: B or C category in stratus and fog under inversion. May improve when precipitation occurs unless drizzle is in the forecast. No improvement until the regime breaks up completely.

(3) __Precipitation__: Thunderstorms/ rainshowers with waves moving along the front.

(4) __Winds__: Variable; mostly ESE or SE 5-10.

c. __Type X__:

(1) __Clouds__: Broken low D category as front passes the station. Stratus is not likely after that time.

(2) __Visibility__: Restricted somewhat in moisture and pollution haze prior to frontal passage (D category).

(3) __Precipitation__: None

(4) __Winds__: S-SW 5-10 shifting to NE 10-15 decreasing and veering thereafter.

5. __SEASONAL FORECAST RULES:__

WINTER

a. If a strong ridge exists over eastern Canada and the Great Lakes, expect a Type E synoptic pattern to degenerate into a major secondary low formation along the East Coast (heavy snowfall at AYE).

b. The rain versus snow decision is defined by the 9,200 to 9,400 foot thickness of the 1,000-700 mb layer and consider the following diagram (see next page).

Type 1: Begins as snow changing to freezing rain.
Type 2: Changes to rain quickly - may be only rain.
Type 3: Light snow or rain.
Type 4: Snow mixed with freezing rain and sleet.
Type 5 and 6: Snow only.

OR AS FOLLOWS:

Surface	850 mb	700 mb	Forecast
36°F	-3°C	-7°C	snow
38°F	-2° to +2°	5°C	sleet
32°F	0°F	3°C	freezing rain

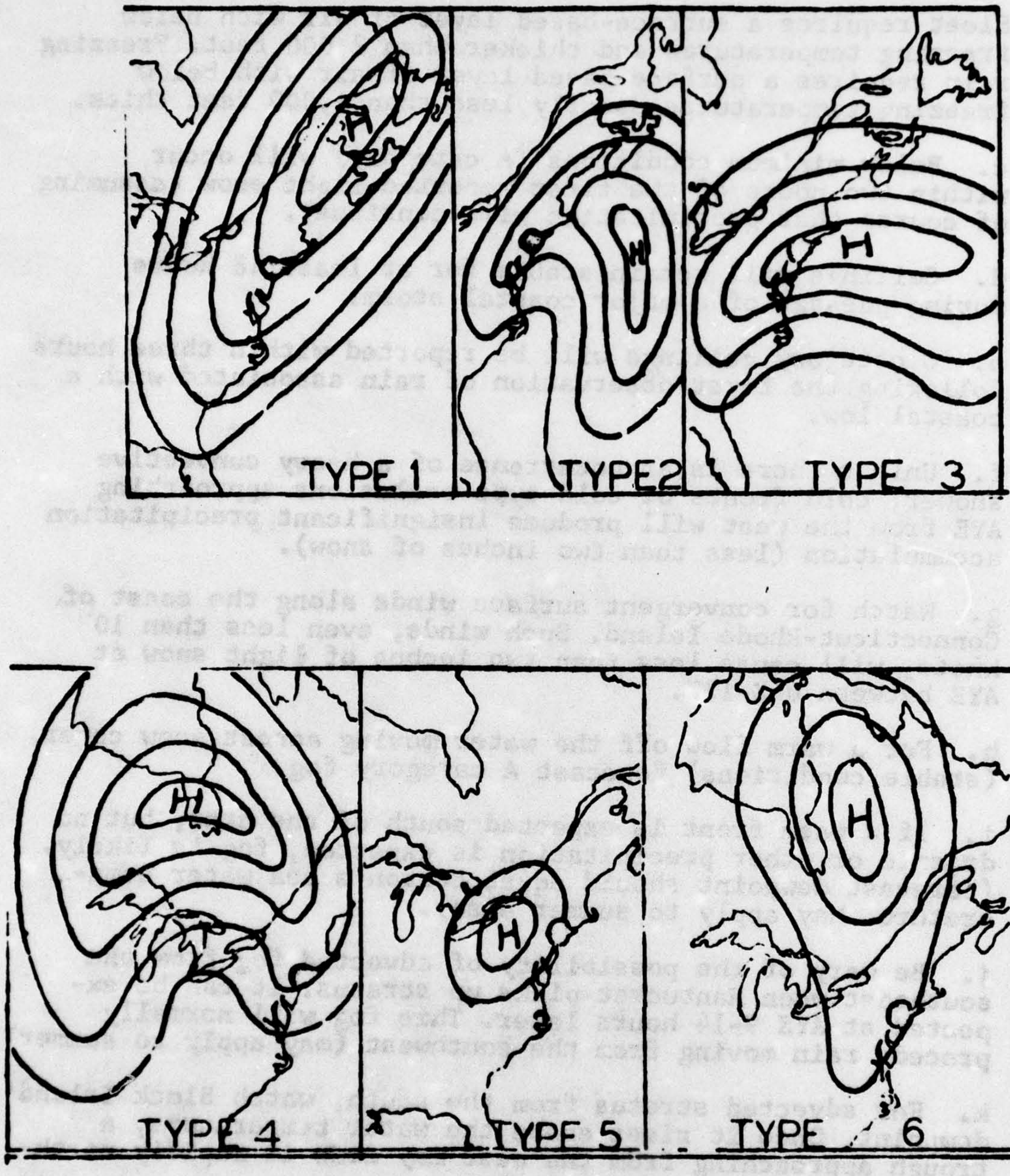


FIG 1

Sleet requires a surface-based layer of air with below freezing temperatures and thicker than 2,000 feet. Freezing rain requires a surface-based layer of air with below freezing temperatures usually less than 1,000 feet thick.

c. Below minimum conditions (A category) will occur within two hours of the first reported light snow (assuming of course that precipitation will continue).

d. Ceilings will remain stable for at least 48 hours during passage of a major coastal storm.

e. C category ceilings will be reported within three hours following the first observation of rain associated with a coastal low.

f. Unless there is an occurrence of a heavy convective shower, cold fronts or cold-type occlusions approaching AYE from the west will produce insignificant precipitation accumulation (less than two inches of snow).

g. Watch for convergent surface winds along the coast of Connecticut-Rhode Island. Such winds, even less than 10 knots, will cause less than two inches of light snow at AYE between 04Z-12Z.

h. For a warm flow off the water moving across snow cover, (stable conditions) forecast A category fog.

i. If a warm front is expected south of the area, but no drizzle or other precipitation is expected, fog is likely. (forecast dewpoint should equal Boston's sea water temperature. May apply to summer also).

j. Be wary of the possibility of advected fog from the southeast when Nantucket picks up stratus. It can be expected at AYE 9-14 hours later. This fog will normally precede rain moving from the southwest (may apply to summer).

k. For advected stratus from the south, watch Block Island's dewpoint. Once it rises above the water temperature, a trough approaching from the west may draw it rapidly northward.

l. Snowfall of more than four inches is normally associated with movement of an 850 mb closed low.

m. Snowfall of less than three inches occurs with southerly flow in winter when a low pressure system tracking southeastward passes over or just south of AYE. The air to the south

at the surface and 850 mb is below freezing with snow cover presently on the ground in Connecticut.

n. Low pressure cells moving across central New England will slow and deepen over the Gulf of Maine. Northerly flow behind these lows will produce about two inches of snow.

o. Surface temperatures at or below freezing with strong packing of the 850 mb and 700 mb isotherms past warm front passage aloft is a likely producer of freezing precipitation.

p. Type C: A shallow but cold surface high cell over northern New England producing northeasterly flow is conducive to prolonged freezing precipitation, especially if snow cover is present.

q. Most gusty winds occur from the northwest or west-southwest during early afternoon especially with clear or scattered conditions. Surface wind approximately equals 80% of the gradient wind with maximum gusts at 80% of the 850 mb wind.

r. Gusty winds from the northwest also occur with coastal systems in proportion to the gradient only.

SUMMER

a. With a back door cold front (spring and summer), fog may occur if the warm air dewpoint is five degrees above the Boston water temperature.

b. By the time the front moves rapidly south of Cape Cod, conditions will improve to C category and then rapidly to E.

c. If rain is produced with such a system, expect a 2-4 hour period of B ceilings.

d. Fog associated with frontal activity may occur if:

(1) A sea breeze regime reaches AYE in the early P.M.

(2) Fog occurred the previous night and there has been no change in air mass.

(3) The dewpoint at AYE is within three degrees of the Boston water temperature.

(4) Sky is essentially clear for at least five hours during the day and evening.

(5) The surface wind is between 030 and 210 degrees.

REGION 8

MID-ATLANTIC COAST FORECAST CUIDES

McGuire AFB	WRI
Dover AFB	DOV
Andrews AFB	ADW
Fort Meade (Tipton AAF)	FME
Fort Belvoir (Davison AAF)	DAA
Camp David	DVD
Martin Airfield	MTN
Langley AFB	LFI
Fort Eustis	FAF

McGUIRE AFB (WRI) FORECAST GUIDE

1. UNITS SUPPORTED: 438th MAW (C-141), 108th TFW (NJ ANG F-105), 170th TAG (NJ ANG C-7), SAC Satellite Operation (KC-135), 514th MTW (AFR C-141).

2. PHYSICAL DESCRIPTION AND LOCATION: McGuire Air Force Base is located 60 miles southwest of New York City at a field elevation of 133 feet MSL. The station is 16 miles south-southeast of Trenton, New Jersey. Ground cover in the immediate area of the base is approximately 40% open fields and 60% wooded country. Most of the surrounding area is relatively flat within 25 miles of the station. The Atlantic Ocean lies 30 miles east of the base; Delaware Bay, 60 miles to the south-southwest; and the Chesapeake Bay further to the southwest. These are the major water bodies affecting the local flying area. The major air pollution sources are the industrial complexes at Trenton, Camden-Philadelphia and Newark-New York City. Anytime the trajectory of the wind is west-southwest through northeast combined with a low-level inversion, pollution may be a problem. Although smoke alone may not lower the visibility below C category, plenty of condensation nuclei are present which increases the possibility of haze and fog. The runway is oriented 24-06.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Although the local flying area is essentially flat, land beyond 25 miles from the station begins to roll from southwest through north. A marked upslope begins at 75 miles from west-southwest through northwest as one approaches the Appalachians. This part of the range is known as the Alleghany Mountains and does provide a marked downslope effect at the base when the trajectory of low-level winds is southwest through north. Indeed, these mountains are the only important topographical effect on weather at the station. Air masses approaching from west-southwest through north-northwest will experience adiabatic heating by a descent of 2,000 to 3,000 feet, greatly affecting the weather on the coastal plain. Precipitation from cold fronts or cP air masses west of the mountains seldom reach this station except as very light showers or squalls. Occasionally, a cold front moving slowly across the mountains will intensify on the lee side with a south to southwest gradient wind ahead of the front causing precipitation and low ceilings for an hour or so. Normally the gradient wind east of the mountains ahead of a cold front will veer to the west or northwest before the front arrives. This increases the effect of the downslope at the station. The lake effect with its extensive cloudiness and precipitation

NEWARK
PLAINFIELD
NEW YORK
COLTS NECK
READING
POTTSTOWN
BETHLEHEM
Flemington
DELAWARE BAY

on the windward side of the Allegheny Mountains does not affect McGuire. When fronts approach from the south or southwest, the worst conditions are observed at the base. The effect of upslope is notable in such conditions as the flow has an easterly component.

b. Air Masses: The primary difference between the stations in New England and those of the coastal plain of the middle Atlantic states is the effect of the air mass trajectory. Continental polar air masses moving north of WRI can produce stratus conditions (witness onshore flow with modified cP highs off the New England coast, back door cold fronts, etc.). A cP air mass moving south of McGuire brings fair weather. In general, this air mass is best for flying activity. With weak frontal activity such as in Types B and E_s, broken ceilings are not likely unless the system is deep. Radiation fog may occur behind the system in late spring or early summer. Fair weather cumulus is the rule. Rarely an mP air mass is formed when a cP air mass slowly moves off the coast modifying in temperature and picking up low level moisture. The location of an mP high is important for forecasting stratus conditions at WRI.

A summer dominant mT air mass is not described in synoptic types primarily because it is a stagnant day in/day out proposition until changed by passage of some type of cold front. In the winter, mT air only appears in the Coastal Plain when a strong warm front moves up the East Coast. Its greatest importance lies in overrunning with zonal or slightly cyclonic southerly flow. In the summer, the Bermuda High dominates the weather at McGuire. Afternoon convective activity is common two to three days after the high becomes stagnant. Visibility is generally restricted to 5-7 miles in haze at sunrise. When the Bermuda High is displaced further west, the entire East Coast comes under the influence of anticyclonic southerly flow with B or C category visibility in the morning and D or E in the afternoon.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See also the Synoptic Type discussion in the Introduction.

WINTER

a. Type B: (Assuming occluded portion of front is that far south)

(1) Clouds: Deterioration from high D category to B in precipitation as long as warm sector stays to the south. Overrunning remains after occlusion passage to 100 miles behind the front. Expect C ceilings as colder air moves into the area persisting until secondary cold front passes.

(2) Visibility: One to three miles in rain and fog will improve to 5-7 if warm front passes. Generally unrestricted after ceiling rises to C category.

(3) Precipitation: Rain intensity depends on the orientation of warm front and intensity of overrunning. Normally does not exceed light rain except right at passage of occlusion.

(4) Winds: ESE 5-10 increasing to 10-20 as occlusion approaches then abating. With a deep cyclone in Ontario, 25-35 knot winds out of the west will accompany the secondary front generally lasting 12-24 hours.

b. Type B_1:

(1) Clouds: Increasing E category middle clouds and cirrus as wave starts up coast. Rapid deterioration to B category in snow, category C in rain (depends on trajectory of low). Improvement expected to D category when low center reaches 40-42°N. Rapid improvement to E category with lower broken conditions only if a strong secondary front is forecast.

(2) Visibility: Unrestricted; may deteriorate to D category in smog, especially if inversion is present. B category visibility in snow, C in rain. If moderate or heavy snow forecast, A possible depending on track of low. Rapid improvement to E with intermittent D in showers after low reaches Nantucket.

(3) Precipitation: Usually snow with a classical Hatteras Low. If the Hatteras Low results from a secondary formation in Type E, then a decision will be necessary between rain or freezing rain, then changing to snow before ending. If the low center goes inland over or west of WRI, rain will occur. Precipitation will begin when developing strom reaches Wilmington, NC.

(4) Winds: NE 5-10 increasing to 25-40 backing to the NW and tapering off as storm continues up coast.

c. Type B_2:

(1) Clouds: Scattered to broken E category middle cloudiness and cirrus.

(2) Visibility: 7 miles (3) Precip: None (4) Wind: N-NE 5-15.

d. Type C: Jet North of WRI

(1) Clouds: Broken to overcast cirrus.

(2) Visibility: Possible D category in morning haze.

(3) Precipitation: None (4) Winds: S 10-15

Jet South of WRI

(1) Clouds: B category ceilings will develop in ENE flow (A if drizzle occurs). Circumstances will not change until regime breaks down.

(2) Visibility: One to three miles in fog and haze to A category in drizzle. No improvement until either front goes back north of station or regime breaks down.

(3) Precipitation: With waves moving along front, expect periods of drizzle or freezing drizzle.

(4) Winds: ENE 5-10

e. Type D: Normally this type will not affect WRI at all as long as the ridge remains over or east of New England over the water. As the upper pattern progresses, however, a warm front will eventually form across the Appalachians into the Washington D.C. area with overrunning to the north. Treat like a Type B if this happens.

f. Type E: (No secondary East Coast low)

(1) Clouds: Center of low moves out of Ohio Valley. Low B category ceilings form as easterly low level flow begins with movement of warm front into Kentucky and southwesterly flow aloft, clouds layered to 25,000 feet. Thunderstorms may be embedded. After frontal passage, broken C or low D ceilings until low moves out of Lake Ontario area.

(2) Visibility: Unrestricted except in showers. Prefrontal fog possible but rare until warm front gets organized. Then B category ceilings/visibility lower in drizzle, higher in rain. Rapid improvement to D or E after front passes.

(3) Precipitation: Rain likely - begins when low low crosses $40^{\circ}N$ (west of Appalachians). Freezing precipitation is a serious problem with this synoptic type. Consult thickness to determine type. Precipitation becomes showery or quits with frontal passage.

(4) Winds: E 5-10 increasing to 10-15 then shifting SSW 10-20 weakening and gradually veering as low moves up the St. Lawrence River.

SUMMER

A. Type B:

(1) Clouds: Center of action is generally too far north to be of any synoptic consequences. D category ceilings associated with thunderstorm activity is the most to expect. C category likely in heavier showers.

(2) Visibility: Unrestricted except in showers. Pre-frontal fog is possible but rarely occurs.

(3) *Precipitation*: *Thundershowers will generally* precede front by a few hours; none thereafter.

(4) Winds: SW 5-10 shifting to WNW 10-15.

b. Type B_3:

(1) Clouds: If the front is south of McGuire, low B conditions can be expected in the morning which of course are apt to burn off by late morning. D or C category ceilings with afternoon and evening thunderstorms and rainshowers.

(2) Visibility: Low B category early rising to D in the afternoon.

(3) Precipitation: Drizzle in morning, showers in afternoon. Precipitation increases with waves moving along the front.

(4) Winds: NE or E, 5 knots morning; 5-15 afternoon.

c. Type X:

(1) Clouds: If a front is forecast to move right on through to the Washington D.C. area, forecast B category ceiling for 4-6 hours and then break clouds up. If the front is close to the station, keep ceilings down until it retreats north again.

(2) Visibility: Two to four miles in haze and pollution when wind first shifts to NE or ENE. Keep deteriorated visibility if front stays just south of station.

(3) Precipitation: None. Even drizzle is not likely.

(4) Winds: SE 5-10. NE-ENE 10-15 after passage quickly dying off.

5. **SEASONAL FORECAST RULES:**

WINTER

a. Low visibility is closely correlated with low ceilings. When A category cloud occurs, A visibility is also likely.

b. If an air mass stagnates over McGuire, visibilities will become progressively lower each day.

c. After cold front passages (Types B and E_s), scattered

occasionally broken cumulus will occur during the day, clear at night regardless of shower activity over the Appalachians. If a closed low at 850, 700 mb exists, there will be persistent post-frontal shower activity.

d. If the winds are in an easterly quadrant, the cloud cover will increase, and the·ceiling will lower (or remain constant) until the wind shifts to a westerly quadrant.

e. Due to terrain effects, easterly winds are not as gusty as westerly winds. Speed of easterly winds is most likely to approach that of the gradient level.

f. Forecasting rain versus snow:

	RAIN	RAIN/SNOW	SNOW
Surface temperature forecast at onset of precipitation	39-40	36-38	34-35
Height of freezing level	$\geqq 2700$	800-2700	<800
850 mb temperatures (^{o}C.)	7 to -2	-2 to -4	-4
1,000-700 mb thickness	>3060		<3060

g. Using the 1,000-850 mb thickness, forecast snow;values less than or equal to 1,290 meters and rain;greater than 1,290 meters.

SUMMER

a. If the dewpoint at maximum heating time is above water temperature (use ship upstream), fog is likely by sunrise.

b. If the dewpoint is forecast 1-2 degrees below water temperature, B category stratus likely.

c. If the dewpoint is 3 or more degrees below the water temperature, no fog or stratus is likely.

DOVER AFB (DOV) FORECAST GUIDE

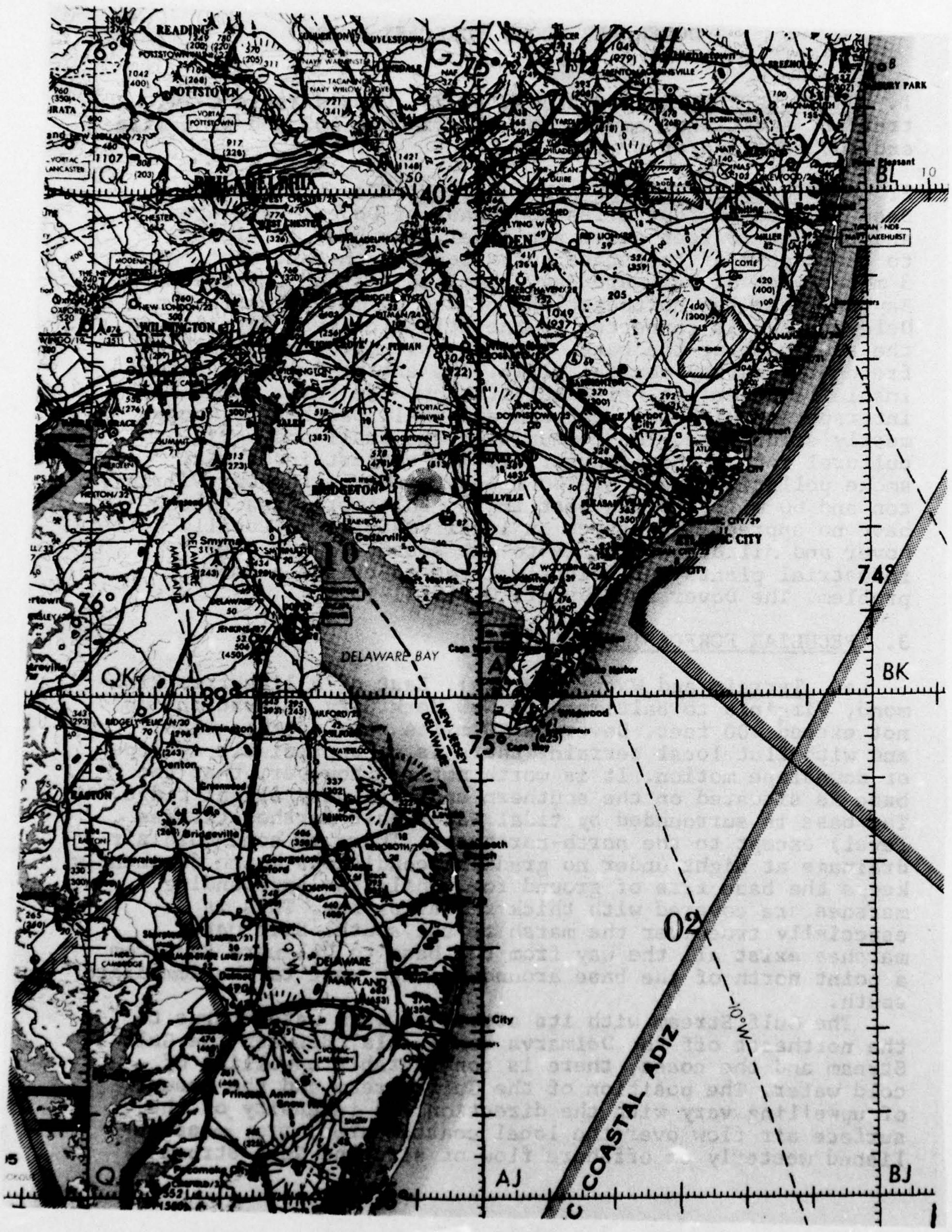
1. UNITS SUPPORTED: 436th MAW (C-5), Considerable C-141 traffic. Additional amendment criteria are 500 and/or 1 mile and 100 feet and/or ½ mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Dover Air Force Base is located four miles southeast of Dover, Delaware and lies at 28 feet above sea level. The base is closer to the center of the state north-south than east-west, about 3 miles west of Delaware Bay, 35 miles east of Chesapeake Bay and near the northeast end of the Delmarva Penninsula. Delaware Bay is connected to the Atlantic Ocean 25 miles to the southeast of the base. Dover is situated on a flat and frequently marshy coastal plain. The entire Delmarva Penninsula is under intensive cultivation, the farms being interspersed with salt marshes and small patches of woods, mostly scrub pine. The communities are small and agricultural rather than industrial. The nearest industrial smoke pollution areas are 40 miles to the north near Wilmington and 60 miles to the west in the Baltimore area. These have no appreciable effect on local visibility. Locally, Dover and Milford, 15 miles to the south, do not have industrial plants sufficiently large to create a smoke problem. The Dover runways are 01-19/31-13.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain and Water Sources: East of a line from Richmond, Virginia to Baltimore to New York City, elevations do not exceed 400 feet. Dover is 40 miles east of this line, and with flat local terrain, there is no appreciable upslope or downslope motion. It is worth noting, however, that the base is situated on the southern end of a very slight ridge. The base is surrounded by tidal water salt marshes (at sea level) except to the north-northwest. There is some cold air drainage at night under no gradient conditions which frequently keeps the base free of ground fog, while the surrounding marshes are covered with thick radiation fog. This is especially true over the marsh to the south. Salt water marshes exist all the way from the base to Delaware Bay from a point north of the base around through east to the immediate south.

The Gulf Stream with its attendent warm water turns to the northeast off the Delmarva Penninsula. Between the Gulf Stream and the coast, there is considerable upwelling of cold water. The position of the Gulf Stream and the amount of upwelling vary with the direction and intensity of the surface air flow over the local coastal area. With an established westerly or offshore flow of air, the Gulf Stream


READING
POTTSTOWN
CAMDEN
DELAWARE BAY
ATLANTIC CITY
NEW JERSEY
DELAWARE
MARYLAND
Smyrna
Cedarville
Denton
Bridgeville
Georgetown
Wildwood
EASTON
COASTAL ADIZ
02
10
40°
39°
75°
74°
76°
AJ
BJ
BK
BL
QK
QL

moves somewhat to the east of its normal position, becomes slightly cooler and encourages more upwelling along the coastal area. With a several hundred mile onshore fetch of air, the Gulf Stream is much closer to the coast, and a considerable amount of the upwelling disappears. In addition, the water of Delaware Bay is colder than the coastal water seven to eight months of the year. However, the Delaware Bay seldom completely freezes over.

From the above, it can be inferred that easterly to southeasterly over-water trajectories originating over or to the east of the Gulf Stream flow move over increasingly colder water to the coast and for the greater part of the year on up the Bay to the base. As the result of this trajectory, there will be cooling and condensation of moisture laden air as it moves to the coast and the base. This is especially true between October and May. With a weak southeasterly gradient, fog will occur on the coast and inland to well beyond Dover. With a stronger flow in excess of about eight knots, some turbulent mixing occurs, and a stratus ceiling of a hundred feet or so will exist, slightly higher during diurnal heating. The visibility will frequently decrease to less than one mile with fog at night during nocturnal cooling.

During the summer months, the above conditions seldom produce fog. However, stratus ceilings of several hundred feet are common at night burning off two to three hours after sunrise. (This is dependent upon the sky condition above the stratus. With an upper or middle forecast broken or overcast, the stratus may stay all day). Typical year-round synoptic situation for this particular fog-stratus condition is for the east-west axis of the Bermuda High to be found to the north of Delaware with a five hundred mile or more trajectory from the east or southeast. A northeast flow is more parallel to the sea temperature isotherms, and thus over water cooling will not occur.

4. <u>SYNOPTIC TYPES AND GENERAL FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction.

a. <u>Type B</u>:

(1) <u>Clouds</u>: Initial cold front: C category in the frontal zone. If wave forms off Hatteras, brief rise to E then back down to C or B in snow as wave moves up the coast. Rapid improvement after the wave reaches 41°N.

(2) <u>Visibility</u>: One to three miles with initial front, rapid improvement thereafter unless precipitation begins again with wave.

(3) <u>Precipitation</u>: Rainshowers. Snow or rain with trailing wave depending on track, temperature and thickness parameters.

(4) <u>Winds</u>: S 5-15 shifting to W, then backing with wave.

b. <u>Type B_1</u>: <u>Type B_2</u>: Same as WRI except somewhat more middle cloudiness will reach DOV.

c. <u>Types C, D, E, and E_s</u>: Same as WRI except wind speeds tend to be higher.

SUMMER

a. <u>Type B</u>: Same as WRI.

b. <u>Type B_3</u>:

(1) <u>Clouds</u>: With the front in the Dover area or to the south especially in late spring, expect A category. If front moves north of the station, expect rapid improvement with land trajectory of wind.

(2) <u>Visibility</u>: A category with less than 200 foot ceilings. Rapid improvement with SW or S wind.

(3) <u>Precipitation</u>: Thunderstorms are possible in the afternoon along the front; otherwise none likely.

(4) <u>Winds</u>: Variable less than 10 except with thunderstorms.

c. <u>Type X</u>:

(1) <u>Clouds</u>: Persistent B category stratus will form as the front moves by and will not break up unless it sinks down into southern Virginia. Expect it to return as the front approaches again from the south.

(2) <u>Visibility</u>: B category along with the ceiling. Rapid improvement as ceiling rises.

(3) <u>Precipitation</u>: None (4) <u>Winds</u>: NE 5-10

5. <u>SEASONAL FORECAST RULES</u>:

a. When snow criteria are going to be met, the depth of course is totally dependent on the storm track. If the track is straight northeast from Hatteras, expect only occasional light snow. If the track of the low is along the coast, expect A category when it reaches 37°N until it is opposite DOV and then back to B. Rapid improvement is forecast as low passes Massachusets coast. If the low turns inland east and north of Dover, the snow will change to rain. (This rule does <u>not</u> apply to the DC area).

b. With a strong Hatteras Low, the exposure of Dover may allow the surface wind to approach the speed of the 850 mb jet for a few hours. The first indications of a strong low development are gusty winds at NGU and LFI.

c. DOV has a much stronger southwest wind in the mean as surrounding stations (210° - 240°). When the gradient would indicate 25-30 knots, DOV can easily top 35, especially if thunderstorms are around (late in the season).

d. If the PSB (Phillipsburg, Va) minus HPN (White Plains, New York) pressure gradient equals 7 millibars, forecast 40 knots at DOV.

SUMMER

a. Sea Breeze (120-140°/ 8-12 knots)

(1) Will not occur if the 850 mb flow is 270-010°.

(2) If southwest flow is greater than 20 knots, none.

(3) Will gust to 20 knots if a southeast gradient exists.

(4) Will kill air mass convective activity.

b. With no change in air mass, expect the visibility to worsen on successive days.

c. To get radiation fog, there is a strong relationship between the surface dewpoint and water temperature.

d. If the dewpoint is equal to or greater than the water temperature, expect fog. If the ground is wet from rain. consider A category.

ANDREWS AFB (ADW) FORECAST GUIDE

1. UNITS SUPPORTED: 1st Composite Wing, 1st ACCS (Air borne Control EC-135), 1st Helicopter Sq, (UH-1, CH-3), 89th MAW (VC-137, 135), 99th MAS (VC-140, DC-131H, V-6), 459th TAW (AFR C-130), 113th TFG (ANG F-105), Det 1, (DC ANG T29, C-121, T-33), New Aircraft and foreign planes.

2. LOCATION AND PHYSICAL DESCRIPTION: Andrews Air Force Base, at an elevation of 279 feet, is located in Maryland just southeast of Washington, D.C. It is on the upper end of a penninsula formed by the Potomac River on the west and south with the Chesapeake Bay on the east. Across the Chesapeake Bay is the Delmarva Penninsula leaving Andrews about 80 miles from the Atlantic Ocean itself. The ground to the south is mostly flat, whereas it slopes upward from the southwest to north. Pollution is a problem at Andrews and is described more fully in Section 3. The main runway is 010-190, 60° against the prevailing flow in winter.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: It is difficult to generalize the terrain in the Washington area as it is broken up especially to the southwest through north. The Allegheny Plateau in the area of 150 NM to the west-northwest averages about 1,000 to 2,000 feet in elevation sloping upward from west to east. There are numerous valleys in this area lying east-west cut as much as 1,000 feet into the basic plateau. MGW, PIT, CRW, LOS, and CSV lie in this area. To the east of the plateau is the Allegheny front with elevations to 3,000 feet in the north portion (northwest of ADW), 5,000 feet 125 NM west of ADW and 6,000 feet in the southern portion. Reporting stations in this area are EKN, JST, BKW, BLF and AVL. The land east of the Allegheny Front drops off sharply to the valley floors with a succession of ridges extending within 50 miles of ADW. The elevations in this area are 2,500 to 4,500 feet high separated by low valleys. Reporting stations are MRB, PSB, CHO, ROA, and HKY. The last eastward extension of the Allegheny Front is about 700 feet MSL, and from there a broad plain extends southeastward to the Atlantic Coast. The width of the coastal plain varies from about 50 miles in New Jersey to 200 miles in the Carolinas. RIC, RDU, CAE and Andrews lie in this area.

In the local area, the Potomac lies eight miles to the west and 26 miles to the south with the Chesapeake 16 miles to the east. The average terrain in the area is 100 feet consisting of rolling hills and shallow stream beds. Andrews' elevation puts it above the surroundings, and fogs forming

HARRISBURG
LEBANON
MIDDLETOWN
BLUE MOUNTAIN
Saxton
Dillsburg
RED LION
HANOVER
Stewartstown
PENNSYLVANIA
MARYLAND
HAGERSTOWN
Taneytown
WESTMINSTER
Parkton
FALLSTON
Bel Air
Shepherdstown
Charles Town
Brunswick
Purcellville
Leesburg
BALTIMORE
FRONT ROYAL
ARLINGTON
WASHINGTON, D.C.
Warrenton
Luray
Culpeper
Orange
Gordonsville
Lake Anna
CHESAPEAKE

in the lowlands have to be advected to the airfield. ADW temperature is also considerably lower (6°F) than DCA which is within Washington itself. Within 25 miles of ADW (moving eastward), strong upslope exists in the NW-SW quadrants and NE-ESE. In other directions, the effect is uncertain. From 25-50 miles (moving eastward), the effect is reversed with marked downslope in the northwest-southwest quadrant and level in the east.

b. Pollution: The bluish-brown haze that pilots see is typical of the Washington area. This is a year-round problem at Andrews with visibility restrictions noted on the average of 174 days per year due to haze and smoke. The larger amount of days occurs in the summer. A stagnating air mass is a problem everywhere along the East Coast, but with all the pollutants available, becomes a serious aviation hazard. The addition of hydroscopic (water absorbent) particulate matter to the atmosphere will further enhance the formation of fog. The situation, of course, remains until a fresh air mass displaces the old crummy one. C and D category visibility is the rule in the early morning with considerably worse conditions when accompanied by fog. Conditions normally improve to high D or E in the afternoon but may not depending upon the degree of stagnation. There are no major pollution sources within five miles of the base. However, further out the effects of industry and salt particles from the ocean take their toll in a period of time as pollution becomes trapped under a subsidence *inversion* east of the Appalachians.

c. Fronts: The mountains have a profound effect on the behavior of Types B, E_s and D fronts as they move in from the west. The ridges tend to block the lower portion of the front and slow it down. The front aloft seems to bulge out ahead. Sometime after the surface front reaches the lee side of the Appalachians, it reforms and seems to accelerate thus allowing the original frontal slope to be re-established (sling shot effect). The timing of surface passage is therefore very difficult. Much of the low level moisture is extracted, however, as the system passes over the Allegheny Front, and the extensive cloudiness from the windward side generally does not reach the Washington area unless the tops are above 8,000 feet. One problem that arises with cold fronts that clear New England and the New Jersey area easily but get hung up in the mid-South, is overrunning of moist tropical air. There should really be a synoptic sub-type introduced for such cases, but the weather is essentially like that for Type C.

4. **SYNOPTIC TYPES AND GENERAL FORECAST RULES:** See Synoptic Discussion in the Introduction.

WINTER

a. Type B:

(1) Clouds: D category ceilings right at time of frontal passage. Watch out for front becoming stationary in the mid-South or for a wave developing off the East Coast.

(2) Visibility: Unrestricted

(3) Precipitation: Nothing sifnificant except brief showers.

(4) Winds: S-SW 10 shifting to WNW 10-15.

b. Type B_1: (Intensity of weather depends on track)

(1) Clouds: Conditions deteriorate very rapidly as low pops over the Appalachians in Georgia. Forecast B category in precipitation if low comes right up the coast. Take it down more cautiously if the low appears to be staying off the coast somewhat. Improvement can be expected when the low center is opposite New York City.

(2) Visibility: Unrestricted until precipitation starts as winds gradually increase. Forecast category B in general with either rain or snow if center is close to coast. Be careful if storm takes a more east-northeast trajectory since visibility is more related to precipitation than lithometeors in this case.

(3) Precipitation: Steady, becoming heavy at times when track of low is close to the coast. Expect precipitation to begin about the time the low reaches Hatteras and becomes erratic as the low passes New Jersey. Although, showers will continue until the low reaches opposite Boston.

(4) Winds: Winds increasing out of the ESE are usually the first indications that the wave is really developing or coming up the coast. ESE 10-15 backing slowly and gusting.

c. Type B_2: (Track through North Carolina)

(1) Clouds: Gradual deterioration as wave moves over Appalachians. Cold air stratus may form with easterly flow off water. Middle cloudiness layered until wave is offshore. Rapid improvement as flow becomes more northerly.

(2) Visibility: Pre-wave fog and haze is possible. Degree of visibility deterioration is dependent on amount and type of precipitation. This is a very difficult parameter to forecast with this type.

(3) Precipitation: Light snow or drizzle as wave passes.

(4) Winds: ENE 5-10 backing to NW 10 as wave passes.

d. Type C: Normally this type will always have polar jet well north of the Washington area. Forecast the same weather as WRI if the jet is indeed south of the Washington area

e. Type D: (see type B) Weather is normally restricted to a small area in the frontal zone.

f. Type E: This type comes in several varieties. The cyclones either come from Montana into the central states and through the Mississippi Valley into the St. Lawrence or come from Louisiana and go up the St. Lawrence. In either case, the weather is the same for the ADW area. An occluded front will cross the Appalachians with the triple point near the DC area or warm front hangs back in North Carolina. Somewhere along the line, someone will have to determine if the secondary wave will form on the lee side,

No secondary

(1) Clouds: Center of low moves out of Ohio Valley. Low B category ceilings form as easterly low level flow begins with movement of warm front into Kentucky and southwesterly flow aloft, clouds layered to 25,000 feet. Thunderstorms may be embedded. After frontal passage, broken C or low D ceilings until low moves out of Lake Ontario area.

(2) Visibility: Unrestricted except in showers. Prefrontal fog possible by dawn as warm front gets organized. Then B category ceilings/visibility lower in drizzle, higher in rain. Rapid improvement to D or E after front.

(3) Precipitation: Rain likely - begins when low crosses 40°N (west of Appalachians). Freezing precipitation may be a problem (consult thickness). Precipitation becomes showery or quits with frontal passage.

(4) Winds: E 5-10 increasing to 10-15 then shifting SSW 10-20 weakening and gradually veering as low moves up the St. Lawrence River.

Formation of secondary low along East Coast

(1) Cloud forecasting becomes really difficult as the timing is critical. The formation of the secondary could really be classified as a separate synoptic type for the DC area because once developed, its behavior is quite similar to B_1. More time is spent on it here because forecasts are generally first busted in the ADW area. Unfortunately, it is difficult to distinguish between the primary cyclone west of the Appalachians and the secondary as it forms. In general, the characteristics are as follows:

(1) The upper air pattern is progressing slowly over the Western Hemisphere (long waves). A baroclinic zone exists east of the Appalachians.

(2) An occluded primary cyclone exists in the eastern Great Lakes but is dissipating.

(3) A shallow wedge of cP air associated with an anticyclone in eastern Canada extending southward on the east side of the Appalachians between the mountains and the Gulf Stream. The shallow cold air is sluggish and tends to remain along the coast during cyclogenesis.

(4) A frontal discontinuity extends across the Appalachians allowing warm tropical air to overrun the cold air mass.

(5) The appearance of precipitation and middle cloudiness not associated with the primary cyclone. A separate maximum in the isallobaric field is also present.

g. Type E_c:

(1) Clouds: Same as Type B, but category D ceilings are not likely.

(2) Visibility: Unrestricted

(3) Precipitation: None

(4) Winds: SE 10-15 shifting to NW 15-30.

SUMMER

a. Type B:

(1) Clouds: D category ceilings with squall-line thunderstorms ahead of front only.

(2) Visibility: Possible D category ahead of front in haze. Rapid improvement with frontal passage.

(3) Precipitation: Showers ahead of front. Hail is rare at Andrews.

(4) Winds: S-SW 10-15 shifting to NW and dropping off.

b. Type B_3: Front south of DC area.

(1) Clouds: A or B category stratus, especially bad in the early morning. May be wiped out by surface heating if front jumps north of area. Otherwise, afternoon cumulus only.

(2) Visibility: Same category as clouds. Restrictions due to haze possible after front moves north of station.

(3) Precipitation: Drizzle possible along with thunderstorms if waves are moving along stationary front.

(4) Winds: Variable 5-10

c. <u>Type X</u>:

(1) <u>Clouds</u>: Flow must be sustained before stratus reaches ADW. DOV can go down and ADW not go down and vice versa. Onshore flow also does not insure fog/stratus. Look for some B category ceilings after frontal passage and again as front either becomes stationary just south of the station or returns as warm front.

(2) <u>Visibility:</u> Category D in haze.

(3) <u>Precipitation</u>: None <u>Winds</u>: Variable 5-10 then shifting to NE 10-15.

5. <u>SEASONAL FORECAST RULES</u>: (Apply to winter and summer)

a. Forecast gusty winds behind front or squall line by expecting a sustained speed equal to movement of front. Add 20% for gusts. (Direction is generally perpendicular to front or squall line).

b. Winds are generally higher (especially gusts) then forecasts made for surrounding stations.

c. Take a 200 mile slice with ADW at midpoint. The pressure difference to nearest .1 mb and multiply by five. This gives the peak wind which can be sustained on the basis of gradient alone. Irregular pressure gradients, low-level inversions and instability will foul up this rule.

d. Southwesterly winds are generally lighter than the gradient would indicate, except when an air mass is unstable. Winds from the northwest are higher than expected.

e. Pre warm-frontal fog is the worst when the front is between ORF and ADW (forecast low B or A category).

f. Post-frontal fog can occur if heavy rain occurs with rapid clearing at night in absense of any pressure gradient to keep mixing in the lower levels (forecast A category).

g. Advection fog may occur after 15-20 hours of sustained easterly flow in the lower levels with a corresponding southwesterly flow aloft. Expect B category. ADW will go down well <u>after</u> DOV. The visibility is lower with a southeasterly wind.

h. Radiation fog (less than 3 miles) will not occur if the gradient wind has an westerly component, there is cold air advection or there was cloud cover the entire previous night.

i. Radiation fog may occur if there is warm air advection, surface wind is 020-180° or there was a clear sky during part of the night previous to formation.

j. With a wind from the southwest to the north-northwest greater than 10 knots, ceiling and visibility will usually be well above operational minimums.(Exception - brief squalls)

k. With a frontal system lying south of Washington, there is a tendency for wave development in southern Virginia or North Carolina. This will usually give a northeasterly wind, overcast skies and rain or drizzle. The height of the clouds and visibility depend upon the proximity of the front.

l. With a deepening low in the Hatteras region moving up the coast, a period of precipitation can be expected at ADW, giving conditions similar to k above. However, under this situation, the surface winds are usually fairly strong and the air unstable, so that ceiling and visibility usually maintain operational minimums.

m. During the winter season, a period of freezing drizzle can be expected under the conditions mentioned in l. above, but will usually be of short duration (less than two hours) due to the warming of the air overvthe Atlantic Ocean and the Chesapeake Bay to the east.

n. With a deep low in the Great Lakes area and a warm front lying southward along the western slopes of the Appalachian Mountains then eastward through the Carolinas, look for development in the Hatteras area.

o. Warm fronts which have moved north of ADW during the daytime and apparently become stationary through southern New Jersey will occasionally move southward after dark, and minor waves will form off the New Jersey coast. Near zero conditions may occur two to three hours after this happens, depending upon the amount of moisture at the surface and the temperature.

p. A deep trough aloft moving over a low in the Gulf of Mexico or through the Gulf States will cause a rapid spread of precipitation up the East Coast.

q. The actual probability of an individual thunderstorm's peak gusts occurring over the field is about 1 to 20, but when the potential is there , so is the risk!

r. IFR conditions resulting from individual air mass thunderstorms can be expected on the average to last 30 to 45 minutes.

s. The movement of individual echoes tracked on the radar does not indicate the movement of a squall-line associated with a cold trough.

t. In the summer, air mass thunderstorms over land should not be forecast for at least two days following the passage

of a cold front. It takes at least two days for low-level moisture to become re-established over the area. This rule appears valid if the front moves well south of the station and offshore from the local area.

u. In cases in which the wind shifts westerly ahead of the front, marked improvement in conditions for two to three hours before the frontal passage can be expected with only a minimum of activity accompanying the front itself.

v. The lowest temperatures are noted during the second or third night following a polar outbreak, when winds have subsided.

w. Haze will persist in the lower layers for three or four days (or until the advent of a new air mass) due to a stationary or slow-moving high, with its resultant subsidence, overlying the local area. Haze persist in the area beginning one or two days following the passage of a cold front.

x. The inclement weather associated with an east-west stationary front located south of the station constitutes the major hazard to aviation particularly during late winter and spring. Ceilings and visibilities are at minimums. Fog, low stratus and precipitation are common.

y. The orientation of a frontal system as it moves through the local area is of the utmost significance in relation to the amount of adverse weather received. Northeast-southwest oriented fronts moving in from the north will often come through dry even in winter months. Generally in the absence of any complicated developmants, the greater a cold front's orientation to the east, the less inclement weather experienced as it moves past the station from the north; also the greater the possibility of it stagnating to the south of the station and moving back again as a warm front.

z. An initial passage of an east-west oriented front from the north to the south of the station will normally result in a minimum of activity accompanying the front itself. However, if it stagnates to the south of the station, it will normally produce two to three days of rain and fog after east or northeast onshore winds develop. North-northeasterly or southeasterly winds will not produce such a situation.

FORT MEADE - TIPTON AAF (FME) FORECAST GUIDE

1. UNITS SUPPORTED: 1st Army Flight Det (OH-53, UH-1, U-21, U-8, T-42, T-41), 97th ARCOM (UH-1, U-8, U-6, CH-47).

2. LOCATION AND PHYSICAL DESCRIPTION: Fort George G. Meade is located 18 miles southwest of Baltimore, Maryland and 20 miles northeast of Washington D.C. Tipton AAF is at an elevation of 147 feet MSL. The surrounding area is composed of tree covered rolling terrain. The AAF is in a depression formed by the drainage area of the Little Patuxent River. The entire area of the airfield is surrounded by tree lines situated on the rim of the depression. The main runway is 10-28. A ½ mile northeast of the field lies the heating plant which may be a pollution source. Other very large sources are on the south and southeast sides of Baltimore which affect FME when light north or northeast flow exists. There is also considerable pollution due to heavy car traffic northwest of the field. Haze is a constant problem except during periods of strong surface winds.

3. PECULIAR FORECAST PROBLEMS:

Terrain: The fact that Tipton AAF lies in a depression encourages radiation fog. FME is only eight miles from the closest inlet of Chesapeake Bay, and it's uphill all the way. Ground fog most commonly forms in the depression during late spring and early fall due to cold air drainage. In the winter, simple nighttime radiation is enough. Advection fogs coming up the hill from the Chesapeake abound when cyclonic activity gets started to the south (warm air off the water over cooler land). The upslope itself causes such fog and stratus to break up more slowly that at some neighboring stations.

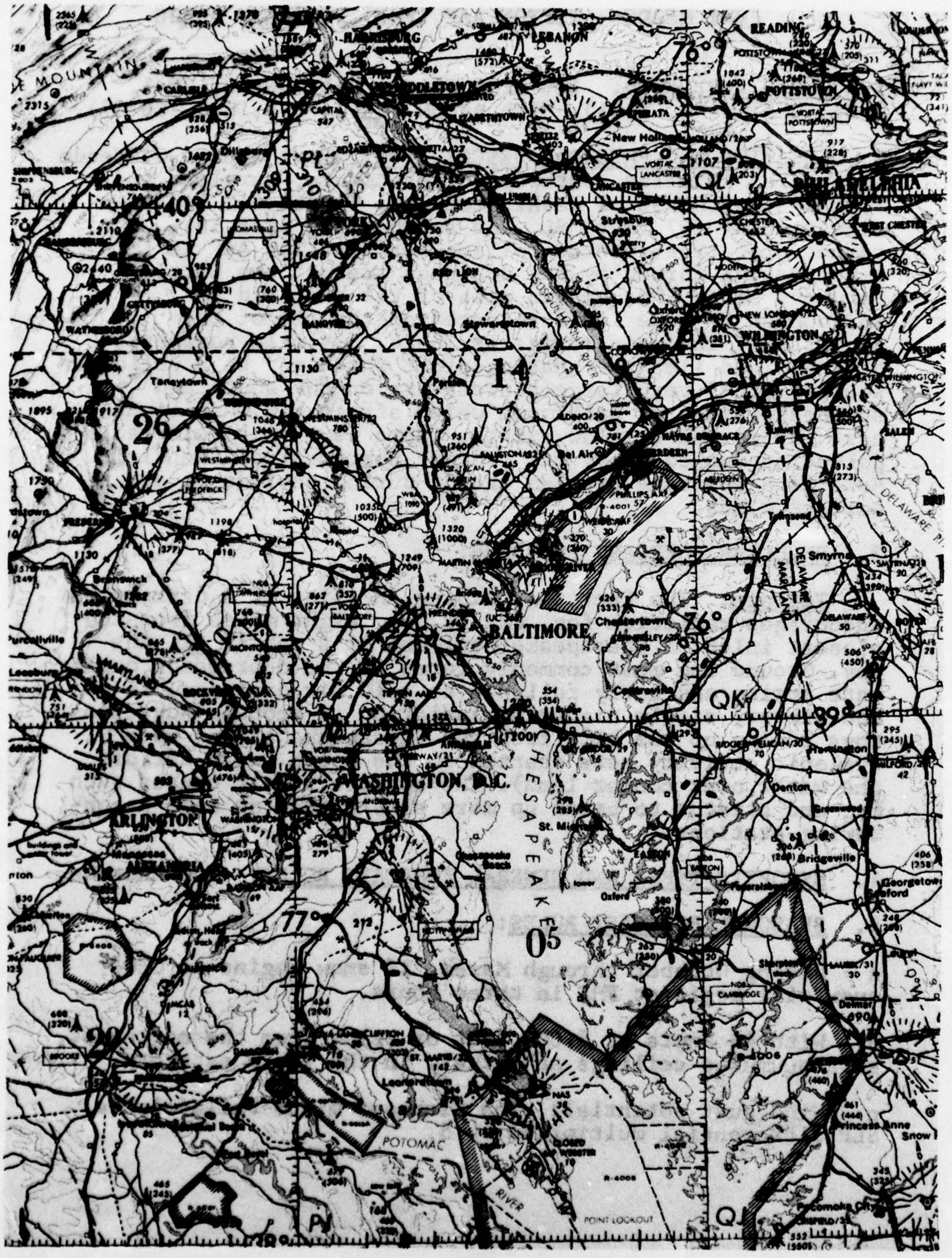
4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Andrews.

5. SEASONAL FORECAST RULES:

a. During October through March, if snow begins at CHO, snow will begin at FME in three hours.

b. With 40 knots at 6,000 feet or below from the northwest, stratocumulus ceilings are likely in the low D category.

c. Wind gust potential: The Richmond minus Philadelphia SLP differential multiplied by 5.



HARRISBURG
LEBANON
READING
POTTSTOWN
PHILADELPHIA
WILMINGTON
Taneytown
BALTIMORE
WASHINGTON, D.C.
ARLINGTON
ALEXANDRIA
Purcellville
Leesburg
Chestertown
Centreville
St. Michaels
Oxford
Easton
Denton
Greenwood
Bridgeville
Georgetown
Seaford
Smyrna
Delmar
Princess Anne
Pocomoke City
CHESAPEAKE
POTOMAC
RIVER
POINT LOOKOUT
DELAWARE
MARYLAND

DAVISON AAF - FORT BELVOIR (DAA) FORECAST GUIDE

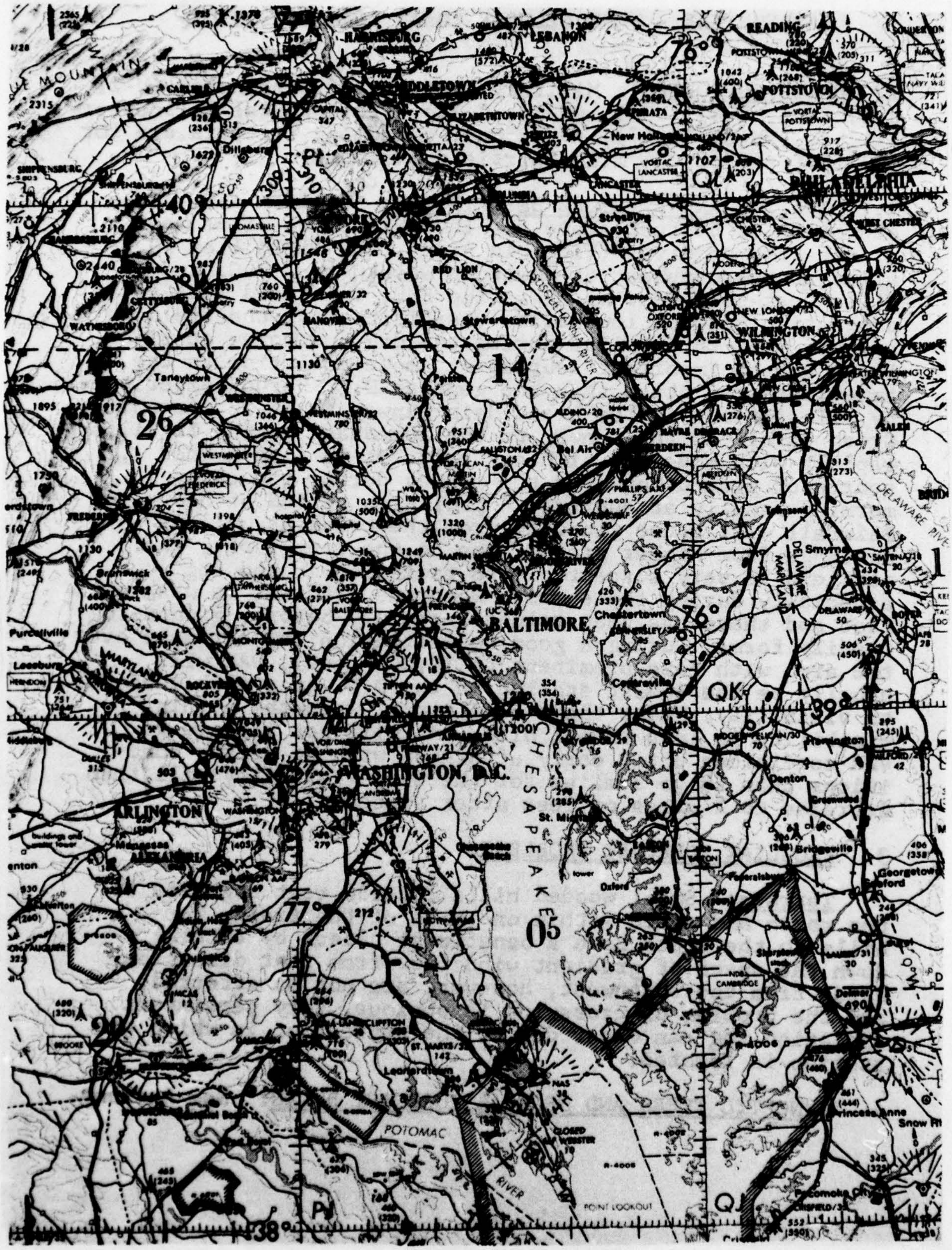
1. UNITS SUPPORTED: Military District of Washington (U-21, U-8, T-42, T-41, UH-1, OH-58, C-12), Presidential Helicopter Flights (VH-3, CH-47). Additional amendment criteria are for 400 feet and/or 3/4 mile (airfield minimums).

2. LOCATION AND PHYSICAL DESCRIPTION: Davison AAF, at an elevation of 69 feet above sea level is three miles west of the Potomac River (Virginia side). The field lies 10 miles south-southwest of downtown Washington, D.C. and 18 miles west-southwest of ADW. Like FME, the field lies in a depression between low hills. Visibility from the field is a maximum of three miles during the day and worse at night. There are no important sources of smoke pollution in the immediate area other than the general D.C. "crud" experienced by all stations in the area. Main runway is 14-32. Accotink Creek parallels the runway to the immediate north. It fills rapidly with moderate or heavy rain. It is also a good source of ground fog over the runway during the early morning usually at sunrise. A prolonged period of heavy rainfall will cause flooding from the creek as well as drainage from higher ground. Due to the topography, the airfield is very susceptible to radiation ground fog especially during the summer. When the gradient is weak or flat and there has been rainfall the day before, ground fog readily forms. During a good fog situation (mT air mass over the area with haze prominent to 10,000 feet), DAA will usually be the lowest station in the D.C. area with respect to visibility. Under these conditions, when the morning visibility is less than ½ mile, DAA will not improve to VFR conditions until early afternoon with no better conditions than 2½ to 3 miles for the day. Visibility will then decrease to 2 miles or less after sunset.

3. PECULIAR FORECAST PROBLEMS:

Terrain: Small wooded hills 100-150 feet high lie to the north and south within one mile of the field. The hills to the south have a beneficial effect by cutting down the speed of gradient wind flow from that direction. Winds from the southwest, however, are not so affected, and the problem of crosswind is obvious. Very persistent radiation fog can occur due to the depression in which the station is located.

4. SYNOPTIC TYPES AND GENERAL FORECAST RULES: See Andrews.


HARRISBURG
LEBANON
READING
POTTSTOWN
CARLISLE
MIDDLETOWN
ELIZABETHTOWN
PHILADELPHIA
WEST CHESTER
RED LION
HANOVER
WAYNESBORO
Taneytown
WILMINGTON
Bel Air
BALTIMORE
Chestertown
Purcellville
Leesburg
MARYLAND
WASHINGTON, D.C.
ARLINGTON
ALEXANDRIA
CHESAPEAKE
Denton
Smyrna
DELAWARE
Georgetown
Princess Anne
POTOMAC
RIVER
POINT LOOKOUT
14
26
05
77

5. **SEASONAL FORECAST RULES:**

a. When other Washington area stations have fog, Davison comes up more slowly than the other stations.

b. During the summer (haze season), DAA rarely comes up above 5 miles and frequently goes down to 1-2 miles at sunset. Again keep in mind the wet ground. A heavy rain-shower 2 days previous will still cause wet land around the base.

c. During the summer, conditions improve rapidly after a frontal passage. During the winter, watch IAD and CHO to forecast improvement at DAA. Cold air stratocumulus is prevalent behind a cold frontal passage in the winter. Bases are in high C category, and the clouds move in with onset of the colder air. Watch for a secondary front which often moves in rapidly off the mountains.

d. Post frontal winds,in the fall and winter, are strongest from 220-360°.

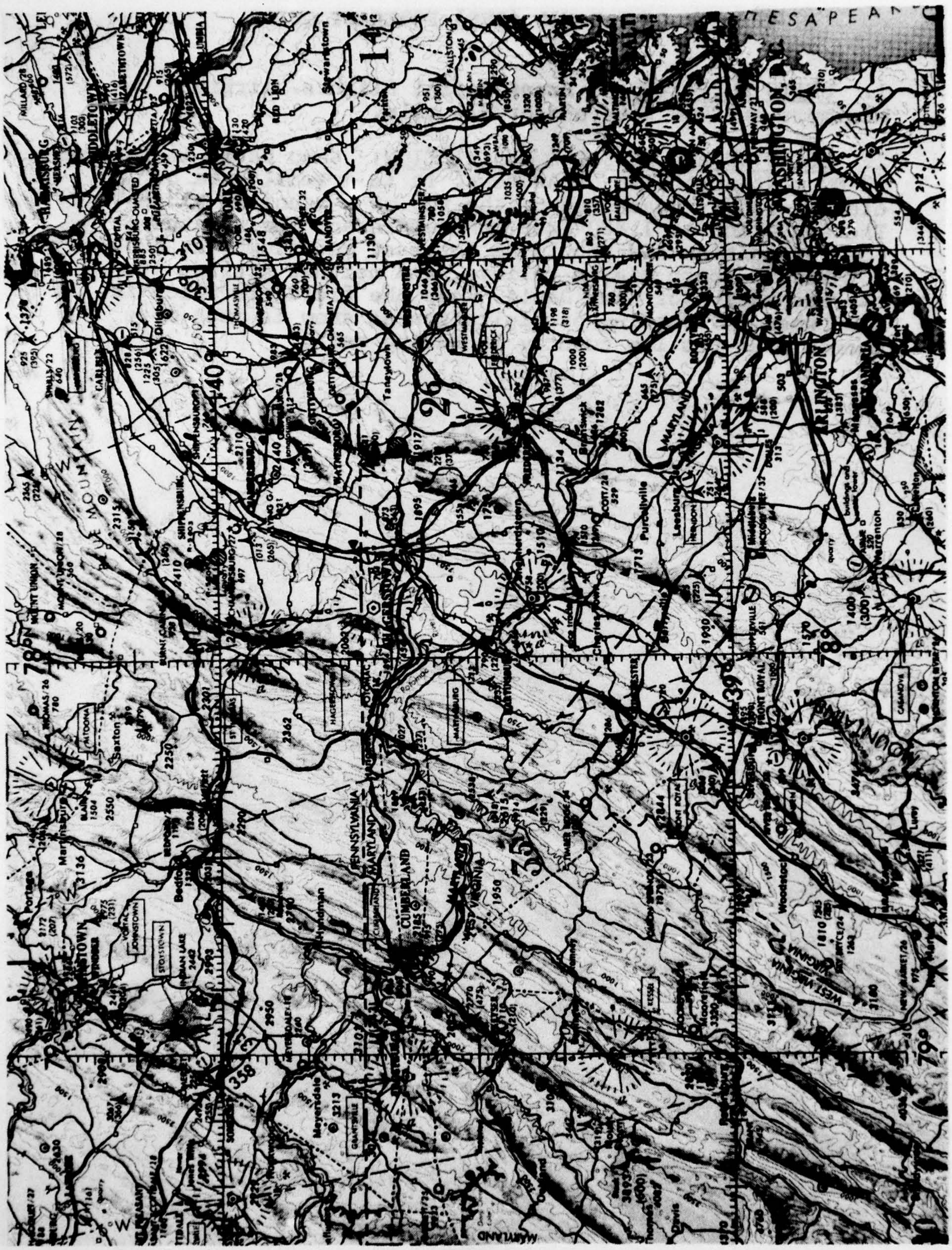
e. When the lower level winds (surface-4,000 feet) are or are forecast to be easterly and southeasterly, do not forecast ceilings to improve to equal to or greater than 3,000 feet. Return flow (anticyclonic) from a trajectory over water produces ceilings below 1,000 feet in the early morning which improve to 1,500-2,500 feet by late morning and afternoon.

f. Because of relationship to terrain, a northeast-southwest gradient (parallel to mountains) will not produce strong gusty surface winds even with a tight gradient. Winds seldom reach 25 knots and will not likely exceed 30 knots.

CAMP DAVID (DVD) FORECAST GUIDE

1. UNITS SUPPORTED: Presidential Flights. Airfield minimums are 400 feet and/or 3/4 mile.

2. LOCATION AND PHYSICAL DESCRIPTION: Camp David is located 63 NM west-northwest of Andrews. It is a small area of cleared land situated along the top of a mountain ridge. The elevation is 1,880 feet, therefore any low stratus or fog forecast at ADW should be forecast much lower at DVD. HGR and MRB both lie in valleys, and neither station is representative of Camp David. Keep the field elevation in mind when forecasting precipitation as snow is much more common when the low country is having rain.



CUMBERLAND
PENNSYLVANIA
MARYLAND
WEST VIRGINIA
VIRGINIA
ARLINGTON

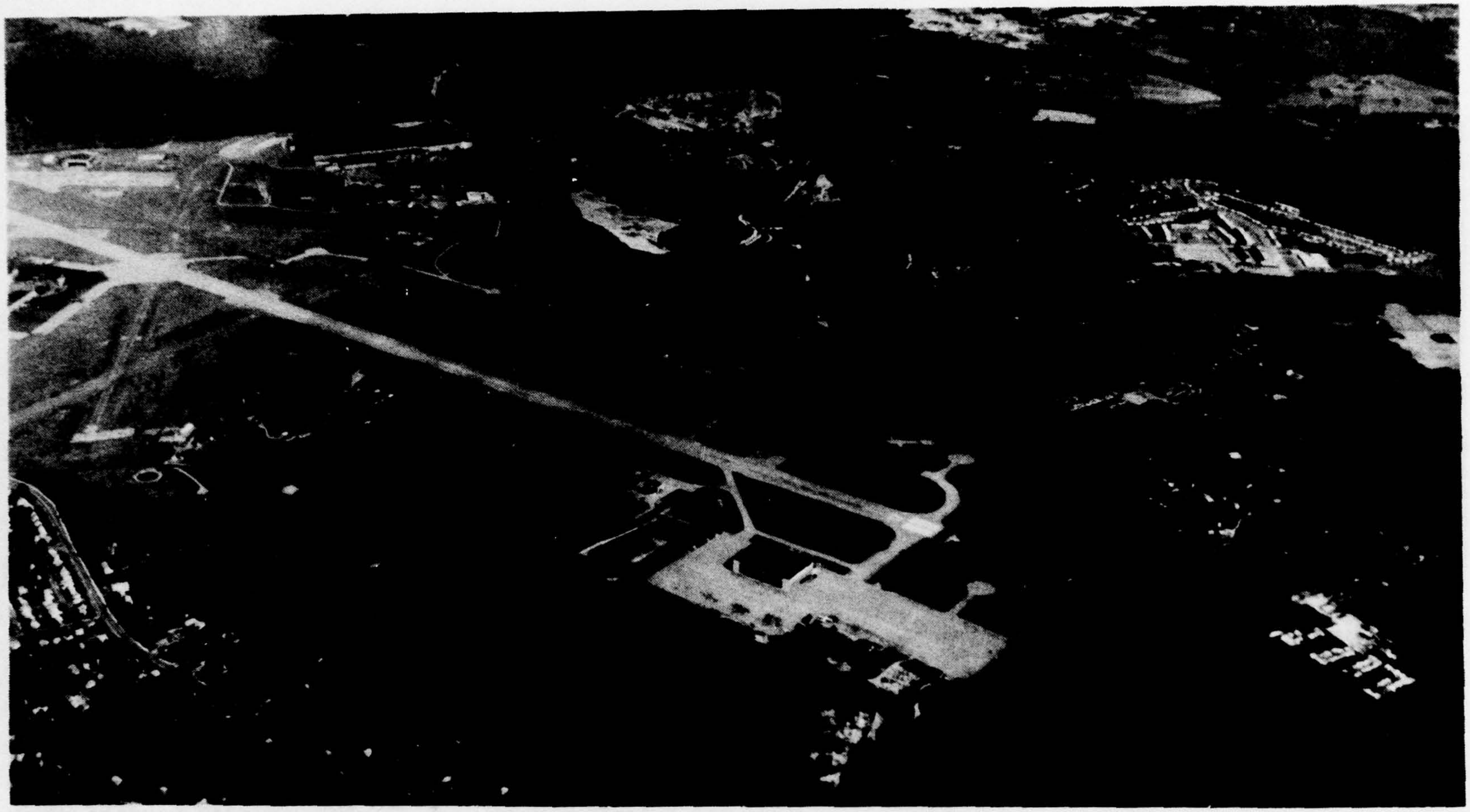
MARTIN AIRPORT (MTN) FORECAST GUIDE

1. UNITS SUPPORTED: 175th TFG (A-37), 135th TASG (O-2).

2. PHYSICAL DESCRIPTION AND LOCATION: Glenn L. Martin Airport lies 3 miles east of Baltimore practically right on Chesapeake Bay. The field lies on a small penninsula that juts out into the Bay and that is part of the ragged Bay shore. The penninsula is surrounded by water on three sides with somewhat less water effect on the northwest corner of the runway which is oriented 32-14.


BALTIMORE
WASHINGTON, D.C.
ARLINGTON
ALEXANDRIA
CHESAPEAKE
BAY
POTOMAC
RICHMOND
Tappahannock
Leonardtown
Chestertown
Centreville
St. Michaels
Easton
Oxford
Warrenton
Culpeper
Orange
Gordonsville
Purcellville
Leesburg
Rockville
Frederick
Taneytown
Ashland
Manassas
Quantico
Brunswick
Chesapeake Beach
WINDMILL POINT
POINT LOOKOUT
CLOSED WEBSTER
MARYLAND
VIRGINIA
CAPE CHARLES
39°
38°
78°
77°
76°

Martin Airport (MTN). View is generally from the west and shows the great expanse of water around and to the east of the field. The RCS is located in the small building at the junction of the buildings forming a "V" at the left of the picture. The active runway runs left to right; the others now being closed.



View of MTN looking more towards the northeast. The ROS is located just below the T-29 on the left of the picture. The RCS is located on the fourth floor of the building. The new wind and RBS equipment will be installed on the west side of the active runway near the crossing.

LANGLEY AFB (LFI) FORECAST GUIDE

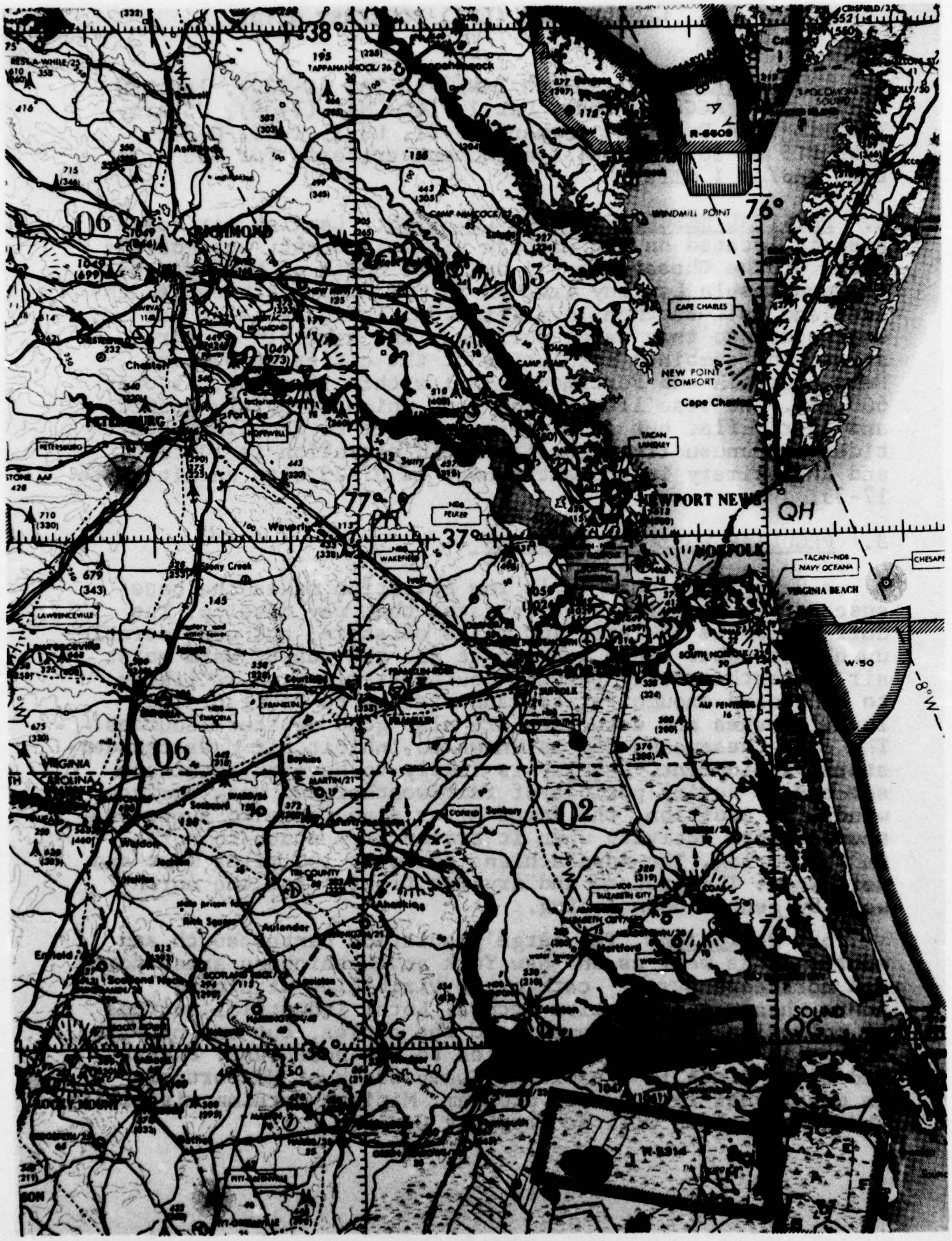
1. UNITS SUPPORTED: 316th TAW/37th TAS (C-130), 1st TFW (F-15), 6th ACCS (C-135), Det 1, 1402 MAS (T-39), US Army Training and Doctrine Command (U-21, UH-1, T-42, U-8), 48th FIS (F-106). Special amendment criteria for ADC - 300 feet and/or 1 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Langley Air Force Base is located on the eastern Virginia coast, west of the mouth of the Chesapeake Bay and just north of Newport News. The penninsula Langley lies on is oriented northwest-southeast and is less than 10 miles wide. The base is on the east side, so that water surrounds the airfield on three sides. The combined population of the cities of Newport News, Norfolk and Portsmouth, all within 15 miles, is over 600,000. The base lies on low land which is partly wooded and fairly flat but is also susceptible to flooding when tides are unusually high. The field elevation is 10 feet, and the primary instrument runway is 07-25 with an alternate 17-35.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Langley's low elevation makes the base susceptible to all fog and stratus that may develop. The Gulf Stream is at least 100 miles offshore, but considerable upwelling takes place between it and the coast. Warm moist air in northeasterly through southeasterly flow is likely to be cooled enough for fog and stratus to develop. The local marshes and estuaries are also good moisture sources. The cold Chesapeake Bay is known to inhibit air mass thunderstorm development. Langley is likely to have an afternoon sea breeze during periods of fair weather and weak surface winds. In addition, the James River also tends to suppress thunderstorm activity when it tracks from south to north in the spring. The Appalachians are over 100 miles west and northwest. They retard and dry out fronts from the northwest by gentle downsloping.

b. Pollution: The large population center south and southeast as well as the New York and Washington areas north and northeast create category D visibility within 36 hours whenever stagnation occurs. Local industrial sources of pollution can not compare to the cities, but one notable source is a refinery a few miles to the northwest. Forest and Brush fires in the Dismal Swamp south of Newport are an occasional late summer problem. Minimum morning visibility under stagnation will be category C.



38°
TAPPAHANNOCK
RICHMOND
Ashland
Chester
PETERSBURG
Hopewell
Fort Lee
WINDMILL POINT
76°
CAPE CHARLES
NEW POINT COMFORT
Cape Charles
R-6609
NEWPORT NEWS
QH
37°
77°
Waverly
Surry
NORFOLK
NAVY OCEANA
VIRGINIA BEACH
W-50
8°W
SUFFOLK
Courtland
Franklin
Emporia
VIRGINIA
CAROLINA
06
03
02
Weldon
Sunbury
Aulander
Rich Square
Hertford
36°
QG
SOUND

4. <u>SYNOPTIC TYPES AND GENERAL FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction.

a. <u>Type B, Winter</u>: Broad troughing over the East is not especially deep. Migratory highs move eastward preceded by cold fronts which may become quasi-stationary along or slightly off the coast. Occasionally, strong lows develop well offshore in the Atlantic which move in from the Southern Plains (Type B_2) or from the Gulf (Type B_1). Development may be associated with a stationary front. The most intense and well known lows that develop are of course Gulf waves which become Hatteras Lows or "Northeasters".

(1) <u>Cold Fronts</u>: Downsloping from the Appalachians retards and weakens such fronts. A moderate cold front will include category D middle clouds and stratocumulus in a band at frontal passage. There will be no visibility restrictions and showers will be light. Post-frontal winds are northwesterly, gusting from 20 to 30 knots in the afternoons up to 36 hours after passage.

(2) <u>Quasi-stationary Fronts</u>: On the east side of the Appalachians, cold fronts oriented east-west usually slide southward rather quickly but then stall south of Langley. South of the fronts, there are scattered low clouds and haze in south-southwest flow. Conditions on the north side degenerate to category B ceilings and visibility with intermittent A visibility. With stable fronts, the band of weather is narrow, but waving fronts or fronts becoming warm boundaries will cause such conditions to spread well northward. (See also Type B_3 - Introduction). Precipitation varies from drizzle along stable fronts to heavy rain and thundershowers near active waves. Watch out for weak waves becoming major storms when they encounter warm open water.

(3) <u>Gulf Waves and Panhandle Lows</u>: These systems may move northeastward on the windward side of the Appalachians and bring warm front conditions to Langley. In 12 hours after formation of the warm front, expect up to 24 hours of category B conditions in stratus, precipitation and fog until the warm front passes the station. Thunderstorms may also occur on the front. Clearing in the warm sector begins shortly after frontal passage. If the wave is a B_2 type (See Introduction) and passes by to the southeast, category B conditions in stratus and intermittent drizzle are likely. The winds may gust to 30 knots from the northwest.

(4) <u>Hatteras Lows</u>: These are intense coastal storms (Synoptic Type B_1) which under strong baroclinic conditions develop from certain Gulf waves. As the system wraps up from Hatteras moving towards Cape Cod, north to northeast winds over 35 knots, category B stratus and light to moderate precipitation occur. Coastal flooding is prevalent with these systems and constitutes another serious problem.

(5) Anticyclone Weather: Migrating highs bring fair weather although stagnation is possible. Exceptions: If a wave develops out in the Atlantic on the front preceding the high, northeast flow may draw in category B stratus particularly at night and in the morning. If morning conditions are clear and calm, on the other hand, radiation fog (category C) may develop at sunrise. Lastly, the return southeasterly flow around the high may be moist and if cooled by coastal waters, lead to late night and morning category B or A fog and stratus. Stronger flow favors the formation of stratus.

b. Type C, Winter: Usually a quasi-stationary high lies near New York or Cape Cod, and stagnation may occur in 36 hours. Morning visibility in severe stagnation are category B on occasion, C the rest of the time. The most common visibility restriction, however, is category D. The quasi-stationary front south of the high is often in the Langley area and is covered in the Type B case above. (See (5)).

c. Type E, Winter: The Texas Low moves up the western side of the Appalachians, but part of the warm front will move slowly up the East Coast and produce classic warm front weather. The development of a secondary wave offshore is a possibility but usually occurs well after the warm front passes Langley. If the front has to move northward from Georgia, it will take up to 24 hours to reach Langley. Category B stratus, precipitation and fog will accompany the front as long as it remains south of the station.

d. Type E_s, Winter: These waves usually move zonally across Florida and cause only overcast cirrus and a few middle clouds at Langley.

e. Type B, Summer: From late spring into late summer, the Bermuda High pushes an east-west ridge into the Carolinas. Langley is usually on the north side of the ridge but still experiences less air mass thunderstorm activity due to the cooling effects of local bodies of water. Afternoon cumulus in southerly flow is common.

f. Type E_s, Summer: This pattern occurs at times in the spring and is typical of late summer and early fall. The Bermuda High is abnormally far south, and fronts reach the area. Approaching from the northwest or west, these fronts trigger thunderstorms in the afternoon, and sometimes form in clusters with the potential for becoming severe. If the front stalls near Langley, it is well to treat it like Type B, Winter.

Late in the season, a following anticyclone may stagnate causing serious visibility problems. If southeasterly flow occurs on the surface, stratus and fog are a possibility.

5. **SEASONAL FORECAST RULES:**

a. **All seasons:** East-west cold fronts move south faster than normal synoptic conditions warrant. (East of the Appalachians).

b. **Summer:**

(1) Winds with components normal to the Appalachians of 25 knots or more will produce a lee side trough on the surface that favors squall-line development as fronts approach from the west.

(2) Backdoor cold fronts generate moderate to severe thunderstorm activity when dewpoints are less than 70°F.

(3) Backdoor cold fronts usually become stationary over Langley or just south of Langley and generate scattered showers/thundershowers (wind less than 35 knots and no hail) during the late afternoon or evening hours.

(4) After passage of an east-west oriented front, which becomes stationary south of Langley, look for ground fog at sunrise to be less than three miles. Visibility will drop to less than one mile if sufficient moisture from a previous day's rain is present. Fog will normally lift to broken stratus within three hours after sunrise.

c. **Winter:**

(1) After frontal passage, given a post-frontal wind from the northwest and ceilings below 3,000 feet, clearing may be expected from 4-6 hours after the wind shift. This will be due to adiabatic expansion of air moving down from the mountains. The clearing line will be observed at AVL and GSP then will progress rapidly southeastward.

(2) Given a cold frontal passage during the forecast period, expect little weather and no precipitation to be associated if there is no moisture at the 700 mb level or above. In most cases, stratocumulus ceilings will stop at the crest of the Appalachians.

(3) Langley will experience approximately 10 knots of wind (gust) for each 1.0 mb pressure gradient reduced to 100 miles.

(4) When precipitation from middle clouds continues/begins, look for low level stratus (IFR) to develop in three to five hours. The stratus will persist if the cause is an overrunning process until the situation changes.

(5) Prolonged northeasterly flow over the Atlantic for a period of 12-18 hours produced by a high pressure

center over Pennslyvania will tend to develop stratus. The stratus will usually form rapidly down the path of the low level trajectory. Infrequently, it will develop against the mountains and back up on successive days toward Langley giving the impression that it is in fact moving eastward.

(6) Very often in winter, a cold ridge lies between Langley and the mountains. When fog or stratus are present after sunrise and the wind increases from the northeast, do not forecast improvement. Watch for a drop of surface temperature and give consideration to freezing or frozen precipitation (given easterly winds above the ridging influence).

(7) In potential Gulf Wave situations, examine the stations in Alabama and Georgia for isallobaric contours and surface wind convergence areas. Usually a new low will be found one to three hours before a definite closed center is observed.

(8) A Gulf Wave potential exists when 300 mb heights over the East Coast increase, and the -15°C isotherm lies over the Gulf.

(9) Snow is forecast when the 1000-700 mb thickness is 9,200 feet or less. The 850 mb level must also be -2°C. or less.

(10) Radiation fog will not occur on successive days.

(11) Advection fog will repeat in southeasterly flow.

FORT EUSTIS - FELKER AAF (FAF) FORECAST GUIDE

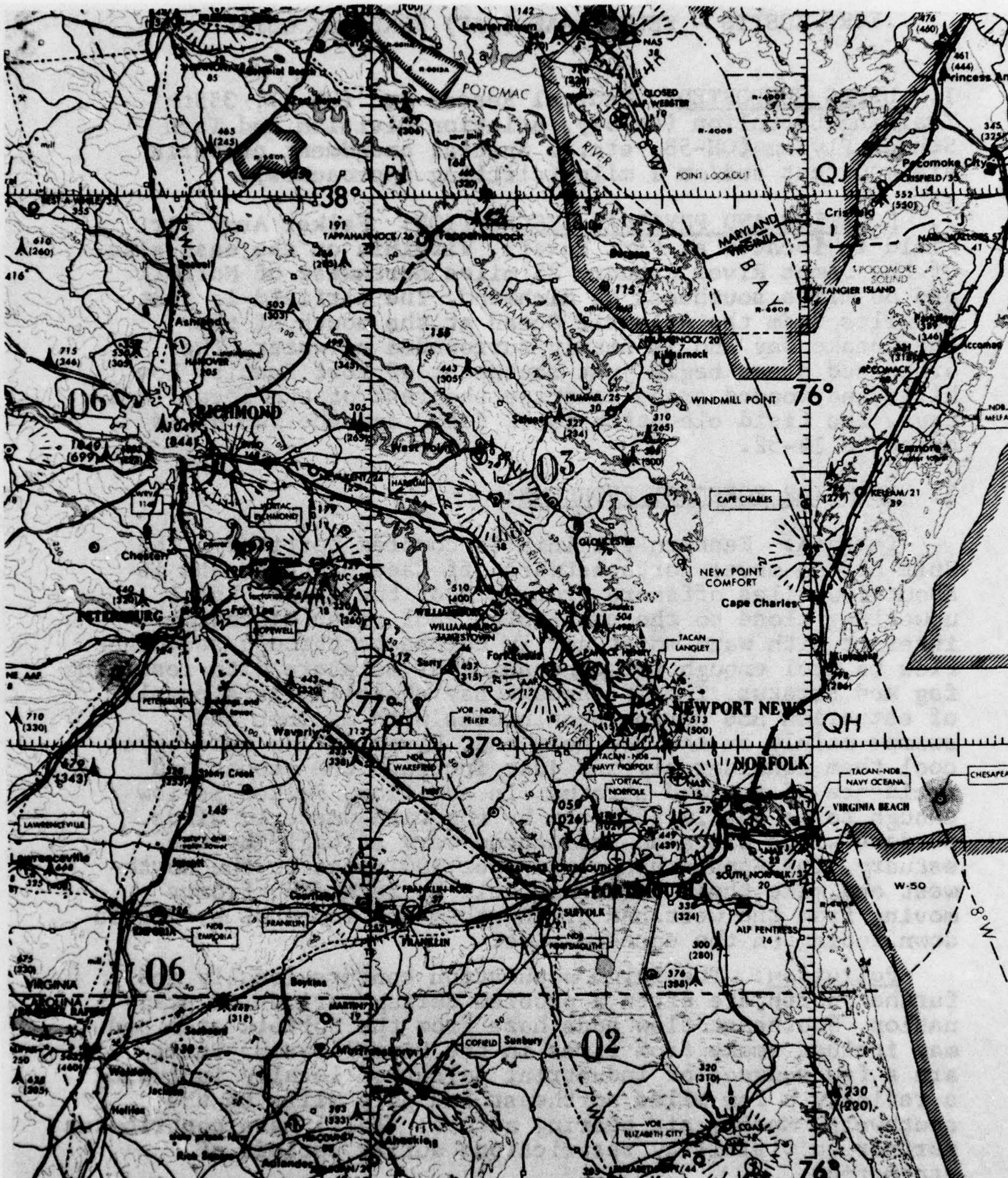
1. UNITS SUPPORTED: Medical Rescue Det (UH-1), 355th Training Battalion (CH-54), Aviation Division and Tech School Flying (OH-58, etc.). Special amendment criteria are 400 feet and/or 1 mile (circling approaches).

2. LOCATION AND PHYSICAL DESCRIPTION: Felker Army Air Field is located at Fort Eustis, Virginia on the east side of the James River Estuary 25 miles northwest of Norfolk and 60 miles southeast of Richmond. The airfield is just 30 miles from the Atlantic Ocean at the mouth of the Chesapeake Bay and is nearly surrounded by water. The urbanized areas begin just southeast of Fort Eustis. Low hills and wooded areas comprise the rest of the local land area. The field elevation is 12 feet, and the runway is oriented 14-32.

3. PECULIAR FORECAST PROBLEMS:

Terrain: Eastern Virginia is complex territory. The Gulf Stream moves northeastward off Cape Hatteras and is about 100 miles offshore from much of the coast. Local upwelling close to the coast plus cool river discharge interact with warm moist air in northeast through southeast flow to cool enough for condensing of moisture with resulting fog and stratus. The Chesapeake Bay shoreline is a complex of estuaries and narrow penninsulas with marshes and swamps mainly on the southern end. River inflow into bays cool them considerably and just increase the amount and incidence of fog and stratus. In addition, Felker is low enough to be easily affected by fog with westerly winds. Surface winds are also influenced very strongly by the estuary. The Appalachians are over 100 miles to the northwest and make their influence felt by retarding fronts moving from the west and drying them out somewhat by gentle downsloping on the eastern side.

Pollution: The large population centers locally and further north are often a problem during periods of stagnation. Southeast flow adds haze from the Norfolk area and may include smoke from fires in the Dismal Swamp. There are a few sources of industrial pollution locally including a refinery a few miles northeast and pulp mills to the southwest. Marine air bearing natural (salt) haze contributes further to visibility restrictions during periods of stagnation.


POTOMAC
RIVER
POINT LOOKOUT
MARYLAND
VIRGINIA
BAY
TANGIER ISLAND
POCOMOKE SOUND
Crisfield
Pocomoke City
Princess Anne
38°
QJ
PH
Ashland
HANOVER
06
RICHMOND
03
WINDMILL POINT
76°
CAPE CHARLES
GLOUCESTER
NEW POINT COMFORT
Cape Charles
Chester
Fort Lee
HOPEWELL
PETERSBURG
WILLIAMSBURG JAMESTOWN
TACAN LANGLEY
NEWPORT NEWS
QH
77°
Waverly
37°
Stony Creek
NORFOLK
TACAN - NDB NAVY OCEANA
VIRGINIA BEACH
CHESAPEAKE
LAWRENCEVILLE
Lawrenceville
PORTSMOUTH
SOUTH NORFOLK
SUFFOLK
FRANKLIN
EMPORIA
ALF PENTRESS
W-50
8°W
06
VIRGINIA
CAROLINA
Boykins
COFIELD
Sunbury
02
VOR ELIZABETH CITY
Hertford
WEEKSVILLE
76°
NAF ELIZABETH CITY
Edenton
ALBEMARLE
SOUND
QG
G
36°
20
30
50

4. <u>SYNOPTIC TYPES AND GENERAL FORECAST RULES</u>: Felker is very close to Langley and has similar weather. See the Langley Forecast Guide for details. The main exception to LFI weather is the greater tendency for advection fog at Felker.

5. <u>SEASONAL FORECAST RULES</u>: See Langley Forecast Guide.

REGION 9

SOUTHERN CALIFORNIA FORECAST GUIDES

Vandenberg AFB . . . . VBG
March AFB . . . . RIV
Norton AFB . . . . SBD
George AFB VCV
Edwards AFB . . . . EDW

VANDENBERG AFB (VBG) FORECAST GUIDE

1. UNITS SUPPORTED: 1st Aerospace Division (1st STRAD), Space and Missile Test Center (SAMTEC), 4392nd Aeorspace Support Group, numerous tenant units and government contractors. The only flying mission is by Det 8, 37th ARRW. Heliocopter minimums are 700 feet and/or 1 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Vandenberg Air Force Base lies on the south-central California coast, 250 miles south-southeast of San Francisco and 125 miles west northwest of Los Angeles. The California coastline turns eastward at Point Arguello on the south end of Vandenberg, so that the base is bounded on the west and to the south and southeast by the Pacific Ocean.

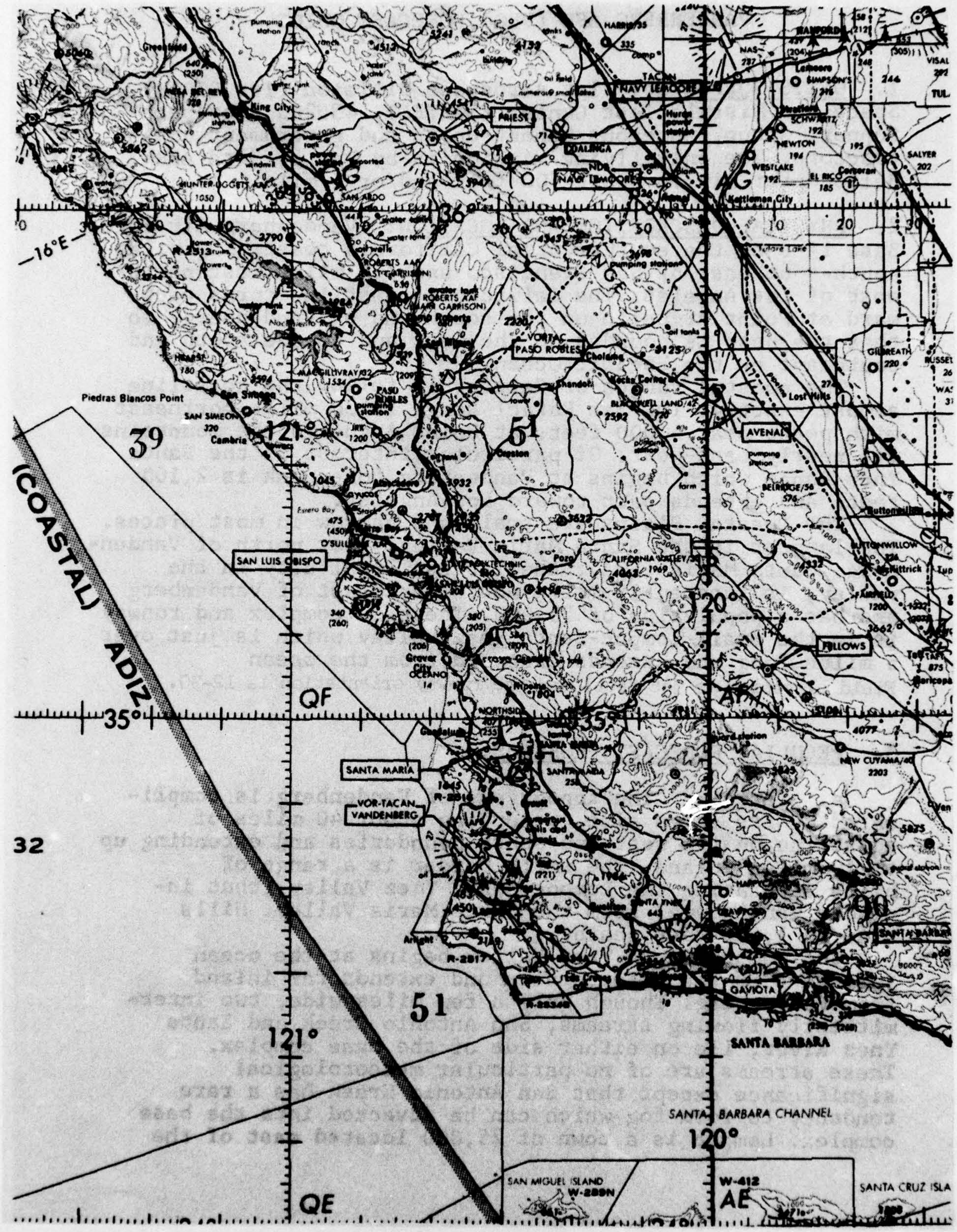
The coastal ranges of California follow the coastline almost exactly. The San Rafael Range is 30 miles northeast with peaks near 5,000 feet. At Point Arguello the mountains lie nearly east-west. Of particular interest is the Santa Ynez Range which begins at Vandenberg (one peak is 2,160 feet) and extends east toward Los Angeles.

The Coastal Plains are small and narrow in most places. The largest is the Santa Maria Valley, just north of Vandenberg. Santa Maria (SMA), the largest local city in the valley, is located 15 miles north-northeast of Vandenberg and has a population of 35,000. The base complex and runway is in the small Lompoc-Santa Ynez valley which is just over 5 miles long and extends eastward from the ocean
Field elevation is 368 feet, and the runway orientation is 12-30.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The topography of Vandenberg is complicated by its large size, occupying about 40 miles of coastline on its west and south boundaries and extending up to 10 miles inland. The north border is a range of hills separating the Lompoc-Santa Ynez Valley (that includes Vandenberg) from the Santa Maria Valley. Hills rise to 1,600 feet nearby.

The Lompoc-Santa Ynez Valley begins at the ocean just west of the base complex and extends far inland from Vandenberg. Though only a few miles wide, two intermittently flowing streams, San Antonio Creek and Santa Ynez River, lie on either side of the base complex. These streams are of no particular meteorological significance except that San Antonio Creek has a rare tendency to form fog which can be advected into the base complex. Lompoc is a town of 25,000 located east of the



(COASTAL) ADIZ
NAVY LEMOORE
PRIEST
COALINGA
PASO ROBLES
AVENAL
SAN LUIS OBISPO
WILLOWS
SANTA MARIA
VOR-TACAN
VANDENBERG
GAVIOTA
King City
San Ardo
Kettleman City
Lemoore
Newton
Westlake
Lost Hills
Piedras Blancos Point
San Simeon
Cambria
Hearst
Shandon
Cholame
Pozo
California Valley
Buttonwillow
Grover City
Oceano
Guadalupe
New Cuyama
Santa Barbara
SANTA BARBARA CHANNEL
SAN MIGUEL ISLAND
SANTA CRUZ ISLA
W-412
W-289N
R-2516
R-2517
R-2534B
-16°E-
35°
120°
121°
QF
QE
AE
39
51
32
90

base and in the same valley. There is some light industry locally, but the area is primarily agricultural.

The Santa Ynez Range begins south of the valley and extends eastward. The highest point is 2,160 feet, so the range is of considerable meteorological importance. South and southeast winds preceding fronts are lifted over the range before reaching the base complex, so that orographic precipitation and downslope flow put it into a rain shadow. Vandenberg receives a modest 13 inches of rain annually, less than half that received in the higher ranges.

Two pollution sources are of interest. Local industry near Lompoc may fill the valley with smoke and dust when there is a low inversion. This uncommon condition resembles ground fog. More significant is smog and haze advected from Los Angeles in southeast winds that occasionally develop in summer (category D). Haze is a normal feature of marine air and this is more important to visibility reductions than pollution.

b. Transient controls:

(1) Stratus Regimes: Fog and stratus forms in the air lying over the cold California Current. Subsiding air in the North Pacific High sets up a powerful inversion from 1,000 to 3,000 feet that traps and confines the marine air. The mountainous coastline confines this air further to coastal plains, and convective heating mixes and destroys it wherever there is penetration far inland. Therefore, the fog and stratus regime is a coastal forecast problem. Because the North Pacific High is by far most influential in the summertime, the fog and stratus regime is limited in generalato the period of May through October with far less of an effect in winter.

Besides the North Pacific High, another factor influencing fog and stratus formation is radiational cooling at the top of the cloud layer which strengthens the inversion (the thermal difference between the air masses may be over 20 degrees C). There is a periodic cycle of development of the thermal low in the California deserts during the summer months. The low deepens as the deserts heat, drawing in marine air which makes a particularly deep and extensive stratus inversion. As the marine air cools the deserts, the thermal low weakens and the marine air inflow ends. At this time coastal temperatures rise and fog and stratus is much less of a forecast problem. As the deserts begin to heat again, the cycle repeats. The irregular period of the cycle averages two weeks.

In the spring and fall, the thermal low may become dynamic. A typical situation has a cold front moving into the area, bringing deep stratus, drizzle

and fog.

In summer weak upper level disturbances may aid or inhibit stratus formation. Often these features are too weak to locate without special analysis techniques.

A close look at the details of fog and stratus formation at a station like Vandenberg is well worthwhile Fog and stratus begins to be a problem at sunset and persists until after sunrise. Category B ceilings and visibilities are typical, and from June through September, such conditions occur from 40% to 85% of all nighttime hours. Category A conditions at night range from 10% to 53% over the same interval. The forecast time of break-up depends on the amount of heating expected, the height of the inversion and the thickness of the cloud layer. In general, assuming normal summertime temperatures, inversions below 1,000 feet and clouds less than 500 feet thick will dissipate by mid-morning. Since inversions with extensive stratus are closer to 1,500 feet and cloud thicknesses nearer to 1,000 feet, only brief clearing is likely during mid-afternoon hours.

Inversions much below 1,000 feet break up quickly with little heating. Those over 3,000 feet high allow the marine layer to mix enough that the moisture content of the air may be insufficient for ceilings. Nevertheless, clouds readily form in the marine layer because of the plentiful supply of condensation nuclei from salt spray and urban pollution. There are never clouds in the subsiding air above the inversion.

The daily cycle of fog and stratus is as follows: The least chance of ceilings is in mid-afternoon, due to simple convective mixing. Inland temperatures and temperatures above the marine air may be in the eighties or much higher, so that the marine air is destroyed as it moves inland and is well mixed out if clouds become thin. As heating diminishes at sunset, the marine air cools and clouds return.

Stratus redevelops through formation processes and simple advection. In the former case, the air cools enough for condensation and then moves onshore with the prevailing northwest winds. Ceilings are typically low (category C) along the coast, unless the stratus is unusually thick with fog below. Because of the relatively high elevation of Vandenberg Air Force Base, category B or A should be forecast.

One particular problem is the forecasting of the time of break-up at Vandenberg. Reference to the morning sounding at Point Arguello (72393) is strongly recommended, for the height of the inversion has been shown previously to be a major forecast aid. Satellite pictures show extensive stratus regimes that probably mean persistent ceilings. On days when break-up seems assured, the penetration of local fog and clouds from the beaches or just offshore remains a problem, one that probably

can not be overcome because of the extreme difficulty in determining the strength of the sea breeze. It is unwise to deviate from conditional climatology and persistence when they call for low ceilings and visibility at forecast time.

Two other comments may be made: First, studies have shown no helpful correlation between stratus and ocean temperatures. Second, though offshore land breezes do occur at night in coastal areas, the effect on stratus is negligible and only doubtful in the case of fog.

(2) Migratory Lows: The majority of storms move northeastward towards the Pacific Northwest and never approach southern California because of the pronounced tendency for ridging over the Far West. Cold fronts do approach Vandenberg, however, weakening and slowing in the majority of cases. Most produce some category D ceilings from middle clouds and stratocumulus on and behind the front. There may also be patchy category B coastal stratus ahead of the front, especially in the spring and fall. Precipitation is light and usually lasts for six hours. Dry fronts are often encountered and are usually no problem.

Active cold fronts require reference to satellite pictures. In many cases convergence ahead of the front produces clouds well in advance; category C stratus and stratocumulus in general with category B at Vandenberg. It is typical for the skies to clear for a few hours after the convergence band passes Then the cold frontal band moves in with similar low ceilings plus higher clouds. Precipitation may be heavy near the front, and in general skies clear after the front passes. Weak, slow moving cold fronts precede much of the cloudiness. Pre-frontal southerly winds are moderate.

Coastal mountains tend to hold back clouds, but ocean areas are generally quick to clear out. The east-west orientation of local ranges at Vandenberg probably does not effectively retard clearing. Because of its exposed position on the California coast, Vandenberg experiences weather typical of the ocean, not of land. The effect of mountains in slowing fronts and holding in clouds does not seem to apply to Vandenberg, as long as the fronts approach from a westerly direction.

Deep Pacific storms are infrequent but are a serious forecast problem when they move onshore through California. Warm fronts generate category B and A conditions as they pass, while cold fronts are active, resembling those of the previous discussion. Post-frontal winds in repidly clearing weather are westerly and may be strong. If the upper level low is northwest, look for particularly active fronts with isolated thunderstorms on the frontal surface and in the cold air behind. Cells develop in the low over the ocean surface and in the mountains during the daytime.

If the upper level low is west or southwest of the station, precipitation and clouds are directed to the south, reducing forecast problems.

(3) Downslope Conditions and the Santa Ana: All coastal locations are vulnerable to the Santa Ana, a foehn wind common to the winter half of the year (October to March). Good potential for such a wind always exists when a Great Basin High builds. However, local terrain influences are extreme. In general, Great Basin Highs should have central pressures over 1035 mbs, and there should be continuing cold air advection into the Great Basin.

In the fall (before mid-December), Santa Ana winds are weak because the Great Basin Highs are insufficiently cold and strong. Coastal areas experience downslope conditions even where winds are weak and warmed by compression to the point where temperatures are quite high. Haze is likely, category D (not a problem at VBG).

After mid-December conditions are right for the true Santa Ana, with stronger winds especially near any hills or mountains, and cool temperatures. Coastal stations typically have northeast winds; the San Jocquin Valley is likely to be fog-bound; and desert temperatures are unseasonably cold. The Santa Ana is often preceded by a dry front coming in from the north or northeast. Winds begin within a few hours of passage, though the actual onset is not at all easy to determine. Winds are characteristically strongest during daytime hours with a minimum of winds in the evening. The Santa Ana usually lasts one or two days and ends quickly as the Great Basin High weakens and moves on. Surface troughing along the coast increases the severity of downslope winds slightly. At Vandenberg the Santa Ana establishes itself quickly and never becomes severe at the runway itself.

(4) Summer Tropical Air: Occasionally during middle or late summer, southeast flow at upper levels brings in moisture from the tropical Pacific, Gulf of Mexico, and Gulf of California. Coastal stations are least affected. Usually there is an abrupt reduction in stratus and fog. Thunderstorms are limited to the mountains in general with coastal areas receiving sprinkles from middle clouds. Vandenberg is far enough northwest to have little more than category D haze and some middle clouds.

4. SYNOPTIC TYPES AND FORECAST RULES:

a. Type B, Winter: "Zonal Flow": Forecast problems center around weakening cold fronts moving in from the northwest. In general, conditions reported up the coast will be a little more severe than those experienced at Vandenberg.

(1) Inactive Cold Fronts: Many have no weather, though a windshift to the northwest may occur at passage time. If stratus and fog is reported when the front is approaching, skies will not clear until some hours after the front is through. Category B stratus with drizzle, light showers, and category C fog is typical.

(2) Active Cold Fronts: Pre-frontal stratus is not typical as in the previous case. Such fronts replace a stratus regime rather than causing it to occur. Category B ceilings and C visibility in rain and fog end as the front passes. Clouds will linger briefly in the local hills. If a low aloft remains offshore, showers and intermittent category C ceilings s persist. Pre-frontal winds may gust to 35 knots from the south. Post-frontal winds will be northwesterly and lighter.

(3) Stagnant Conditions: If a persistent ridge over the Far West maintains a surface ridge west of California into the Great Basin, category D haze from urban pollution occasionally may occur. In the fall there may be a heat wave (no problem at VBG).

b. Type C, Winter: "California Low": A strong ridge aloft over the Pacific Northwest is manifested by a surface high in the ocean near Washington, and an upper level low lies over southern California. Northeast flow results in strong surface winds that give Vandenberg gusts to about 25 to 40 knots late at night and into the morning for two days or so. Evening winds are light.

c. Type D, Winter: "Colorado Low": This pattern allows surface storms to move into central or northern California, continuing into Nevada and on eastward. Accompanying weather resembles the active cold fronts of Type B, Winter, above.

d. Type E, Winter: "Gulf Wave": An upper level low off southern California allows some frontal activity (mostly open waves on a quasi-stationary front) to affect areas mostly south of Vandenberg.

(1) Frontal Activity North: Minimum conditions include category D middle clouds and occasional category C stratocumulus if precipitation occurs.

(2) Frontal Activity South: Quasi-stationary fronts are hard to locate and warm or cold portions may not be discernable. In general, expect category B stratus and nimbostratus with moderate to heavy rain for 12 to 36 hours. Periods of category D middle clouds will be reported. When fronts move southeast, conditions are as given in (1) above until the upper level low dissipates or moves south and/or east.

e. Type B, Summer: "Low Amplitude Flow": The forecast problem of the stratus regime has been discussed in Section 3b. Moisture surges of tropical air from the southeast are infrequent and weak at Vandenberg.

5. SEASONAL FORECAST RULES:

a. Fog and Stratus Break-up in Summer: Yes, if the 12Z Point Arguello sounding (72393) indicates clouds to be under 500 feet (15 millibars) thick. Ceilings are least likely in the middle afternoon. (Held 68% of the time in one test period.)

b. Surface temperatures of 70 degrees F or more keep ceilings out until after sunset. (86% verification.)

MARCH AFB (RIV) FORECAST GUIDE

1. UNITS SUPPORTED: 26th Bomb Wing (B-52, KC-135). 303rd ARRS. California ANG (F-105).

2. PHYSICAL DESCRIPTION AND LOCATION: March Air Force Base lies in the southeast part of the San Bernardino Valley and is six miles south of Riverside, California. Since RIV is only 14 miles south of Norton Air Force Base, the general area topography is not repeated here. The portion of the San Bernardino Valley upon which March lies is relatively rough and elevated. Pollution sources besides the dominant urban smog include industry near San Berhardino to the north. The rest of the area around March is largely agricultural. The field elevation is 1,532 feet and the runway is oriented 13-31.

3. PECULIAR FORECAST PROBLEMS:

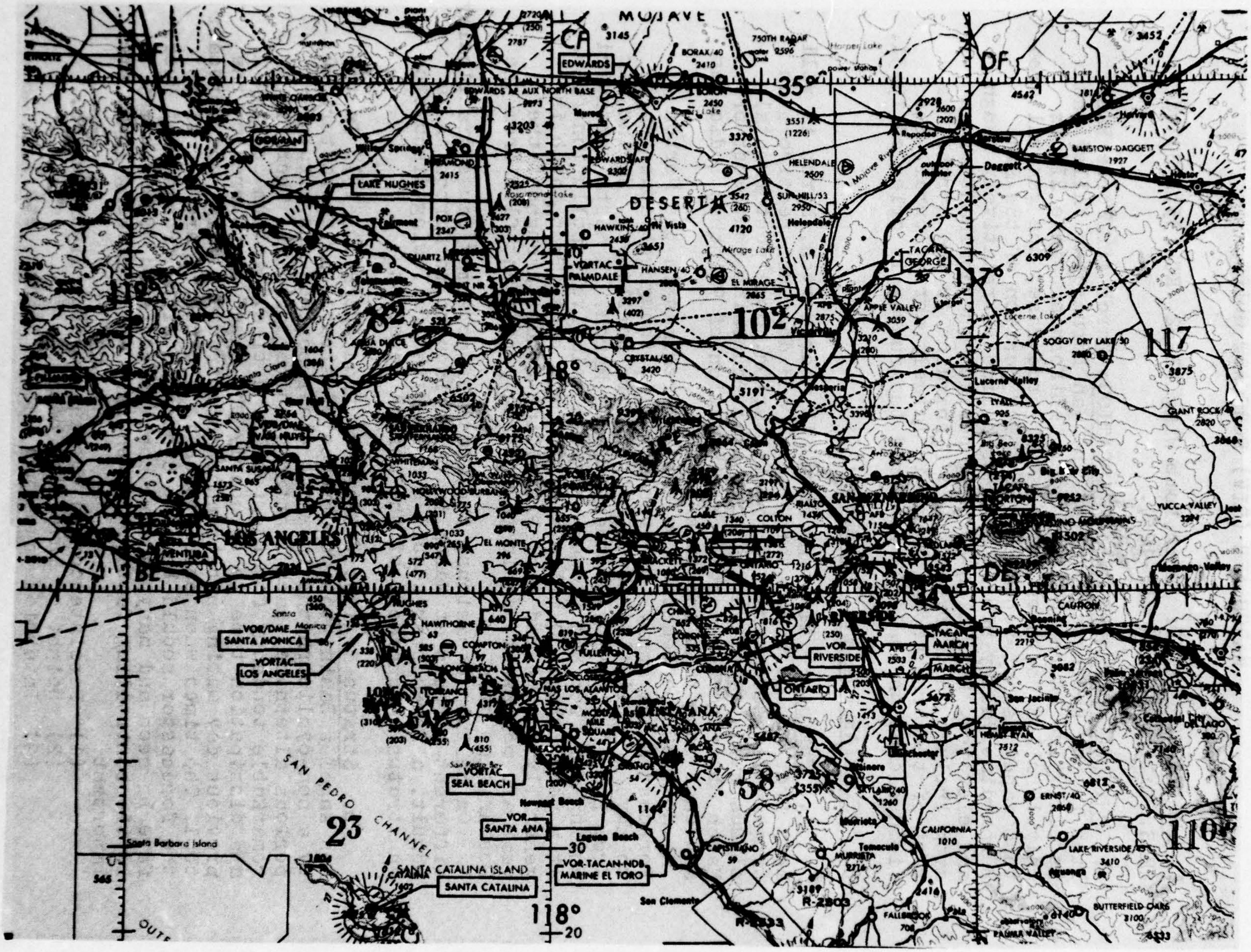
a. Terrain: Although March is near Norton, March is well away from the high mountain ranges and does not receive much orographic cloudiness and precipitation. Some post-frontal clouds may persist in the Santa Ana Mountains southwest of March, but the low annual precipitation of 9 inches indicates at least some rain shadow effect.

Most of the comments on stratus regimes in the Norton Forecast Guide apply to March as well, though stratus tends to move in a little slower but be more persistent. Marine air from Los Angeles moves directly over March. It meets northward moving air from San Diego, which is relatively pollution free, at a point about 30 miles south of the base. Thus March is generally in the bad air. Prevailing winds throughout the year are northwest, again indicating persistent flow from the Los Angeles area.

On certain occasions, the local effects may cause drastically different effects at March in comparison to to Norton. As a result, a forecaster should consider the following discussion on stratus independent of the Norton forecast.

b. Stratus Regimes: (Excerpts from AWSTR 105-13). In the Los Angeles Basin, the occurrence of stratus is characterized by a non-cyclic rhythm in which clear periods and stratus periods alternate, each lasting a number of days. There is a remarkable tendency for the formation time, minimum ceiling and dissipation time to be nearly the same as occurred on the previous day making persistence an extraordinarily good forecast tool. The times when persistence is not useful are the times the forecaster should be most concerned with. Trends must therefore be seen and many factors considered, each of which may be the controlling factor. In general, the following items are important:

(1) Persistence and current stratus distribution.
(2) Height of inversion base.
(3) Inversion magnitude (weak, strong, etc.)


MOJAVE
EDWARDS
DESERT
LAKE HUGHES
VORTAC
PALMDALE
HELENDALE
EL MIRAGE
APPLE VALLEY
TACAN
GEORGE
BARSTOW-DAGGETT
SOGGY DRY LAKE
LOS ANGELES
VENTURA
VOR/DME
SANTA MONICA
VORTAC
LOS ANGELES
HAWTHORNE
COMPTON
FULLERTON
ONTARIO
VOR
RIVERSIDE
TACAN
MARCH
COLTON
EL MONTE
VORTAC
SEAL BEACH
VOR
SANTA ANA
VOR-TACAN-NDB
MARINE EL TORO
SAN PEDRO CHANNEL
SANTA CATALINA ISLAND
SANTA CATALINA
Santa Barbara Island
CALIFORNIA
LAKE RIVERSIDE
BUTTERFIELD OAKS
YUCCA VALLEY
Lucerne Valley
118°
35°
117°

(4) Height of inversion top.
(5) Temperature of inversion base.
(6) Trend of inversion over past 48 hours.
(7) Presence of upper clouds.
(8) Maximum surface temperatures observed and forecast.
(9) Surface dew points and depression.
(10) Current visibility and distribution of visibility.
(11) Surface map: fronts, isobar orientation, position of Great Basin High and thermal low position, intensity.
(12) Pressure gradient.
(13) Pressure tendency at desert stations.
(14) Tendency of heights aloft for past 48 hours.
(15) Streamline curvature at 850, 700 and 500 mb.
(16) Wind direction at these same levels.
(17) Depth of Catalina Eddy.
(18) Duration and strength of sea breeze.

The height of the inversion base generally coincides with the top of a stratus deck. In general, the temperature of the inversion base increases with increasing height of the base. The inversion base is the coldest point in the lower troposphere so clouds form first and dissipate last at this level. When the inversion base is high, formation is early and dissipation late. Formation time is even earlier when there is an increased number of smoke and pollution particles. When the inversion base is on or near the ground, clear skies or fog result. Keep in mind that the inversion base is not horizontal through the Los Angeles Basin due to topography, diurnal effects, insolation, sea breeze, etc.

The inversion magnitude can be defined by the temperature difference between base and top. An inversion of small magnitude is more susceptible to lifting and sinking than is one of large magnitude. Thus, one would not expect a strong inversion to change in height very much during the day. The height of the inversion top is much more stable than the base. It should be carefully watched as a rise in the top may mean that the entire inversion is lifting.

The occurrence of clouds aloft causes the rate of cooling by ground radiation at night to be reduced, and there is a resulting tendency to delay formation. Upper clouds also indicate a change in air mass from the normal summer condition. When upper clouds result from the advection of thunderstorms or form in moist tropical air from the south or southeast, the winds should be carefully examined to detect possible Foehn effects or lowering of the inversion from subsidence in an anticyclonic current aloft. There may be some correlation between the presence of such clouds and no stratus. This would be especially logical if the upper clouds resulted from a weak front, and the temperature of the new air mass was significantly cooler.

The maximum surface temperature is very important (more so at RIV and SBD than on the coast) as Foehn winds are usually evident at inland stations before coastal stations. The dew point has some forecasting value as an indicator of the type of

air over the station. Stratus usually does not occur if the dew point is below 45°F in the afternoon unless a rapid influx of marine air occurs during the evening.

Low visibility often precedes stratus formation. Air pollution affects visibility and similarly may be the cause of condensation observed at relative humidity levels well below 100%.

Frontal passages are special problems to forecasting the stratus regime. In general, definable fronts on the surface or troughs aloft will raise the ceiling but greatly thicken existing stratus with accompanying drizzle. If the air mass is potentially colder than air that would have normally have been over the station, the stratus may clear out. Strong winds also will break it up.

The isobar orientation is parallel to the coast under domination by the Pacific High. Changes to that orientation produce changes in the stratus regime as with intensification of the Great Basin High which produces a Foehn effect. Pressure tendencies should also be used in this analysis.

In general, rising height aloft will cause the inversion base to sink. Use the 1200Z to 1200Z change and 0000Z to 0000Z change to eliminate the diurnal effects. Along the same lines, curvature of streamlines aloft affect the vertical stretching or shrinking of the air column. This also has an important effect on the inversion height.

The Catalina Eddy, the low pressure area frequently observed between Catalina Island and the Santa Barbara Channel Islands, appears to result from strong northwesterly flow breaking around the sharp Coast Ranges at Pt. Arguello. Increasing depth of the Catalina Eddy indicates that the Pacific High is approaching the West Coast. This local pattern can exist up to 6,000 feet at times and is probably related to the daily sea breeze circulation.

Conditions generally favorable for a clear night are:

(1) Falling inversion trend.
(2) No ceilings the previous night.
(3) Rising heights aloft.
(4) Easterly winds aloft.
(5) Increase in maximum temperature.
(6) Surface isobar orientation more favorable.
(7) Less stratus on coast than on previous day.
(8) Decreasing on-shore pressure gradient.
(9) Sea breeze begins late and is weak.

Factors favorable for stratus formation are:

(1) Slight cyclonic curvature of streamlines aloft
(2) Increasing depth of catalina eddy.
(3) More stratus on coast than previous day. (NUC San Clemente Is. should have a 600 foot ceiling - elevation is 900 feet MSL)
(4) Slightly higher dew points than previous day.

b. Transient Controls: See the Norton Forecast Guide for further information on stratus and haze regimes, migratory lows, downslope conditions and Santa Ana winds. The treatment of summer tropical air in that Guide is also representative.

4. SYNOPTIC TYPES AND FORECAST RULES: (See SBD, note exceptions)

a. Type B, Winter: "Zonal Flow": Unlike SBD, the clouds generally clear up at RIV after the front passas. Reduced visibility is common ahead of the front.

b. Type C, Winter: "California Low": Visibility in morning Santa Ana winds may briefly be category C in dust.

c. Type D, Winter: "Colorado Low": Treat the same as Type B above.

d. Type E_c, Winter: " Gulf Wave": Precipitation tends to be very intermittent and light at March as orographic influence is considerably lessened.

e. Type B, Summer: "Low Amplitude Flow": Rules on stratus and smog forecasting apply generally to March. (See Section 5 of Norton Forecast Guide). Stratus at Norton is almost always matched by similar clouds at March, but cloud tops should be reported above 2,500 feet in the evening at Los Angeles to insure similar midnight-to-noon stratus at March.

Summer thunderstorms are less frequent at March, though they form readily over the Santa Ana Mountains to the west and southwest.

5. SEASONAL FORECAST RULES:

a. Santa Ana winds occur at March with the same frequency as Norton but with less speed and accompanying hazards. In general, winds are northerly with 20 to 30 knot gusts during the daytime.

b. In the Summer, if the 500 mb height exceeds 5900 meters, the probability of stratus is greatly diminished at RIV. If the 850 mb height exceeds, 1510 meters, there will be no stratus. (AFGWC tested rule)

(1) Corollary - If a high cell at 500 mb is progged to be right over the Los Angeles Basin, there will be no stratus at March. (Or at Norton either).

NORTON AFB (SBD) FORECAST GUIDE

1. UNITS SUPPORTED: 63rd MAW (MAC); 445th MARW (MAC)

2. PHYSICAL DESCRIPTION AND LOCATION: Norton Air Force Base lies in a heavily urbanized area between San Bernardino and Redlands, California, in the northeast corner of the San Bernardino Valley. Los Angeles is 55 miles west and the Pacific Ocean is as close as 45 miles to the southwest. The San Gabriel and San Bernardino Mountains, oriented east-west, are as close as six miles north of Norton. Most peaks are 6,000 feet high (as close as six miles north of Norton), but isolated peaks northwest and east exceed 10,000 feet. Other mountains include the San Jacintos over 30 miles southeast (tops to 11,000 feet) and the Santa Ana Mountains, which lie beyond 25 miles south and west, blocking marine air from directly reaching Norton except through Los Angeles. Peaks rise to 5,500 feet.

Pollution sources are primarily urban, for Los Angeles smog routinely noves into the San Bernardino Valley. There are several minor local industrial and agricultural pollution sources which combine with the Los Angeles and Long Beach industrial smog to produce frequent visibility restrictions. Agricultural pollution consisting of springtime crop dusting and winter smoke from citrus heaters (smudge pots) is almost non-existent today, accounting for less than one percent of the pollution.

Field elevation is 1,156 feet and the primary instrument runway is oriented 05-23 (primary instrument approach is to runway 05).

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The seemingly complex topography around Norton can be simplified somewhat by discussing the effects of terrain on area weather. Of primary importance to coastal stations in southern California is the fog and stratus regime. Norton is so for inland that onshore flow must travel 60 miles and is likely to be thoroughly mixed with drier air through convective heating before reaching the base. In winter the sea breeze usually does not penetrate into the San Bernardino Valley. Norton's prevailing winds are light easterly, 3 to 5 knots, primarily a drainage effect at night from snow capped mountains. From March to September, however, strong incursions of marine air brings fog and stratus from late night through morning hours. Visibility remains low in smog (also brought in by marine air). Marine air flows over Norton into the desert through Banning Pass and also into interior valleys south of the San Bernardino Valley, so Norton is always affected to some extent by onshore flow and its associated problems.


EDWARDS AF AUX NORTH BASE
BARSTOW DAGGETT
HECTOR
Daggett
HELENDALE
DESERT
HAWKINS
VORTAC PALMDALE
HANSEN
EL MIRAGE
TACAN GEORGE
APPLE VALLEY
Victorville
R-2501N
SOGGY DRY LAKE
Lucerne Valley
R-2501S
GIANT ROCK
CRYSTAL
118°
117
117°
102
VORTAC POMONA
SAN BERNARDINO
NORTON
SAN BERNARDINO MOUNTAINS
Big Bear City
YUCCA VALLEY
Joshua Tree
MCB TWENTYNINE PALMS
Twenty-nine Palms
HI DESERT
CAJON
RIALTO
COLTON
EL MONTE
BRACKETT
ONTARIO
CHINO
CORONA
FULLERTON
VOR RIVERSIDE
RIVERSIDE
TACAN MARCH
MARCH
ONTARIO
Morongo Valley
PALM SPRINGS
CAUTION
Banning
Palm Springs
Cathedral City
San Jacinto
Hemet-Ryan
Winchester
Elsinore
SKYLARK
BERMUDA DUNES
La Quinta
VORTAC THERMAL
58
110
NAS LOS ALAMITOS
SANTA ANA
VORTAC BEACH
Newport Beach
VOR SANTA ANA
Laguna Beach
CAPISTRANO
VOR-TACAN-NDB MARINE EL TORO
CATALINA
Temecula
MURRIETA
CALIFORNIA
ERNST
LAKE RIVERSIDE
Aguanga
BUTTERFIELD OAKS
CLARK LAKE
San Clemente
R-2503
R-2533
118°
FALLBROOK
Pala
PAUMA VALLEY
WARNER SPRINGS
BORREGO VALLEY
SALTON SEA
OCEANSIDE
MCALF CAMP PENDLETON
OCEANSIDE
117°
Borrego
OCOTILLO
Ocotillo
LAKE WOHLFORD
Carlsbad
Encinitas
GULF OF
CD
DD
33°
JULIAN
AGUA CALIENTE SPRINGS
SANTA CATALINA
TACAN-NDB NAVY MIRAMAR
NAS
SAN DIEGO
SAN DIEGO
SAN DIEGO LINDBERGH
TACAN-NDB NAVY NORTH ISLAND
TACAN-NDB

The San Bernardino Mountains and other local ranges are so close to Norton that the base receives additional rainfall from orographic effects (about 11.5 inches annually, which is somewhat higher than other interior valley stations). It is normal for frontal clouds to remain at Norton after all other coastal stations have cleared. Usually frontal passage is not obvious, for clearing is delayed considerably by the mountains. In summer occasional air mass thunderstorms develop over these same peaks, but they drift over Norton and other coastal areas only if southeasterly surges of tropical air are evident. This is most likely in July, August and September, but only infrequently.

Norton is fortunately southeast of Cajon Pass, for winter Santa Ana winds may gust over 75 knots out of this pass alone. Mountains near Norton are rather uniformly high so the base typically receives northerly winds of 25 to 35 knots (rare gust to 50 knots in strong "Santa Anas") in the daytime. Clear air turbulence on the lee side of the mountains is always present with a "Santa Ana" from the surface through 14,000 feet. Moderate turbulence for C-141 aircraft is common and structural damage in flight has occurred with a more intense "Santa Ana". Late afternoon and evening winds are light and more variable. Northerly winds are classified into two groups: "Santa Anas" and cyclonic. The "Santa Anas" are caused by high pressure in the Great Basin and feature anticyclonic curvature, while the cyclonic winds result from lows to the east of Norton and feature cyclonic curvature (see checklist items in Section 5). Often the cyclonic winds occur first followed by Santa Anas the next day. On occasion moderate northerly winds occur in conjunction with deepening winter lows in Nevada, usually after a trough or front has passed. Such winds gust to 35 knots at most, but may be supplemented by a true Santa Ana in 24 hours if a Great Basin High moves in as the storm moves out. If the winds blow at night, there probably is some cyclonic influence.

b. __Transient Controls__: Both migratory pressure systems and local effects are important.

(1) __Stratus Regimes__: In winter stratus is an irregular or uncommon forecast problem; but from March through September, this problem dominates all others (April through June is the primary stratus season). It is helpful to read the corresponding discussion in Section 3c of the Vandenberg Forecast Guide and then refer to this one to see the modification of the regime to Norton.

Basically, a marine air mass results from the lowest layers of the atmosphere being cooled and moistened, while subsidence from the North Pacific High clamps down a powerful and persistent inversion overhead (near 1,500 to 4,000 feet in general). The sea breezes carrying the marine air mass

can and do rise 1,000 feet to reach Norton. Marine air is advected as a part of a large scale process and maintains itself sufficiently to affect Norton. This air will contain varying combinations of stratus, smog and fog. In the spring stratus prevails since inland temperatures are too low to effectively mix and destroy the air mass. Also, some large scale processes are particularly active in the spring and advect marine air efficiently. In the summer inland temperatures are high and mixing is often thorough. At such times smog may prevail. Usually stratus and smog alternate daily as forecast problems.

What are these large scale processes that advect marine air to Norton? In the spring and fall, lows in southern Nevada sometimes deepen and draw in the northwesterly flow off the Pacific, including marine air that passes into the desert through numerous passes in southern California, including those in the Norton area. In many instances the low appears to be static, but a weak cold front moves in from the northwest and the low becomes dynamic. Coastal cloudiness is most pronounced ahead of the front or trough as the inversion rises in response to a vertical motion field.

In the summer the periodic cycle of the thermal low (as discussed in the Vandenberg Forecast Guide, Section 3c), exactly applies to Norton. If the marine air invasion is strong and deep, stratus occurs from midnight through sunrise until noon. Visibility remains low throughout the day with fog and haze accompanying the stratus and smog in the afternoons. If the invasion is weak, there will be little stratus except briefly before and at sunrise. Smog will persist at all times, though visibility reductions will be less serious than in the former case.

There is a third large scale process affecting the stratus regime. When northwest winds around the North Pacific High pass Point Arguello at Vandenberg, they are gradually cyclonically turned into a low level low called the Catalina Eddy, with the southern extent near San Diego. Satellite pictures often show this eddy since it is accompanied by heavy stratus. Stratus may reach Norton from San Diego to the south or through Los Angeles in the usual fashion. The Catalina Eddy is part of the thermal low cycle discussed above. The Catalina Eddy is very dominant in assisting the advection of stratus into Norton. A simpler definition of this effect is a surface wind at San Diego (SAN) from 150° to 240° for three consecutive hours.

The cycle of stratus and smog at Norton may vary little from day to day, so it is essential to consider persistence when forecasting. Many fog and stratus studies have been undertaken in southern California and they all agree that it takes much experience and detailed information to successfully deviate from statistics. Some rules of thumb and important forecast parameters will be presented in Section 5.

(2) <u>Migratory Lows</u>: Northwesterly fronts usually are quite weak as they enter southern California. Many are nearly dry. More active fronts include category D middle clouds near the front with stratocumulus remaining near the mountains for several hours prolonging the ceilings at SBD. Precipitation is light and intermittent.

More intense storms moving across central California eastward bring more active cold fronts. Ceilings will lower to category B in stratus and nimbostratus with moderate rain a few hours before the front reaches the Los Angeles area. Visibility is at least category C. As coastal areas clear, clouds remain but rise to low category D for several hours with showers. As the storm moves into the desert, moderate northerly winds may develop after the front passes, gusting to 35 knots for 24 hours. Watch for a possible Santa Ana development after the "cyclonic" winds end.

(3) <u>Downslope Conditions and the Santa Ana</u>: Refer to the Vandenberg (VBG) Forecast Guide, Section 3c for details. All coastal areas of southern California are similarly affected.

At Norton downslope conditions result in a heat wave that can bring temperatures to 110 degrees in September (the most likely month). Northerly winds are light and visibility reductions in haze are not typical, though category D is possible late in the day.

True Santa Ana winds occur from late October to March, typically giving northerly winds of 25 or 35 knots during the daytime. Gusts to 50 knots require particularly strong Santa Ana situations. Afternoon winds are typically stronger at Fontana and cities west like Ontario (ONT) than at Norton. Usually the strongest winds occur the first day and weaker winds the second and occasionally, the third day (25 knots). Comments in the Vandenberg Forecast Guide referring to the strength of the Great Basin High necessary for winds and the indication of the termination of winds by the high's weakening and movement apply at Norton as well. However, Santa Ana regimes set up more readily at Norton and more days with winds are experienced.

(4) <u>Summer Tropical Air</u>: From July through September, southeast winds aloft bring in tropical air from the Tropical Pacific, Gulf of Mexico, and the Gulf of California. Thunderstorms develop in the local mountains in the afternoon and usually dissipate at sunset. Ordinarily they remain in the mountains, but particularly strong moisture surges may carry them over coastal areas in the evening or later at night. Norton experiences brief ceilings of category D with category C or D haze and light showers possible. Smog is often a problem at this time, but stratus is less common due to the weakness of onshore flow.

Tropical storms rarely come onshore in the Baja Peninsula, 100 miles or more south of Norton, producing more serious moisture surges aloft. Extensive altocumulus may lower to category D with rainshowers and embedded thunderstorms with haze occurring as in the previous case. Ceilings may persist several hours at category D and may occur at any hour, although hours around noon seem to be less affected. The wind direction (and sometimes speed) reported by the AMOS at Sandberg, California (SDB), 4523 feet MSL, is considered the best indicator of frontal passages in southern California.

4. SYNOPTIC TYPES AND FORECAST RULES:

a. Type B, Winter: "Zonal Flow": In the spring and fall, fronts may approach while a stratus regime is in effect. In such cases frontal passage will normally clear stratus out unless the front is exceptionally weak.

(1) Maritime Cold Fronts: No problem. If stratus is in, category B clouds and C visibility in fog or haze clear out with the front. The time of passage will be hard to determine due to terrain at Norton. Use the indication of SDB to find the front.

(2) Active cold fronts: The category B stratus regime will be supplemented by stratocumulus and middle clouds, with intermittent precipitation as the front arrives. Visibility is also category C, as in the above inactive front case. Clearing will be delayed several hours by clouds hanging over the mountains. Santa Ana winds, however, can occur if a Great Basin High sets up.

(3) Stagnant conditions: Typically, static ridging covers the Far West at the surface with frontal activity far away in the northwest. Category D smog is normal, and morning visibility may lower to category C or even B in severe cases. Downslope conditions, indicated by a heat wave usually mean category D visibility (or better) at all times.

b. Type C, Winter: "California Low": Strong ridging over the Pacific Northwest both at the surface and aloft means that Santa Ana conditions are entirely possible. The upper level California Low is usually south or east of Norton.

c. Type D, Winter: "Colorado Low": Migratory lows move across northern California moving east. Active cold fronts resemble those of Type B, Winter above. Many are moderate to strong with post-frontal clearing delayed several hours at Norton.

d. Type E$_s$, Winter: "Gulf Wave": An upper level low off California is always a threat until it dissipates or

moves eastward overhead. Surface fronts precede these lows but may stall and allow wave formation to begin. Warm and cold fronts are hard to separate, but in general, category B ceilings, B or C category visibility and moderate rain persist until the fronts move through to the southeast.

The low itself brings showers and isolated thundershowers to the mountains with periods of low category D clouds and showers to the valleys, so long as the low is west of SBD and quasi-stationary. Norton will likely have persistent ceilings in the afternoon and evening as low as category C with intermittent rain as the trough passes through.

e. Type B, Summer: "Low Amplitude Flow": In Summer, the primary synoptic feature is the thermal low - sea breeze cycle. Moisture surges from the southeast are an occasional middle and late Summer problem.

5. SEASONAL FORECAST RULES:

a. Summer Fog-Stratus Regime: Critical forecast parameters are the height of the inversion and the thickness of the stratus layer at Los Angeles from which the marine invasion comes. There are two routine soundings transmitted on the wire at the moment; LAX and EMT (El Monte) at 1400Z and 2000Z Monday through Friday. In addition, LAX transmits on weekends and holidays. (LAX = 72295, EMT = 74704). Pilot reports can also be used and will correlate the tops of the stratus with the base of the inversion.

(1) Stratus at Norton: Stratus must be present along the coast from Newport Beach and Santa Monica since almost all stratus is advected from the ocean.

(2) The height of the inversion is seldom horizontal throughout southern California, and so reports outside of the Los Angeles Basin are very misleading. A variation of 100 feet in the height of the inversion can mean the difference between stratus and no stratus at Norton.

(3) A stratus invasion at midnight is most likely if satellite pictures indicate extensive stratus offshore (especially if the Catalina Eddy is present), if the thermal low in the deserts is deep (so that a pressure gradient across the coastal areas is evident in the surface analysis), if pilot reports in the evening at Los Angeles show cloud tops above 2,000 feet and if stratus was reported the previops day. Stratus takes six hours to move from the ocean to Norton and is broken up by heating during mid-day.

(4) YES or NO

(a) Stratus along coast - as above.
(b) Inversion base above 2,000 feet.
(c) Pressure gradient LGB-DAG = 5 MB or more (24 hr) trend is important.

(d) 500mb trough aloft or just to west. Forecast yes.
(e) 850mb height at LAX less than 1500 meters at 14Z, forecast yes.
(f) Pressure gradient trend increasing - forecast yes. If decreasing, forecast no.
(g) Maximum temperature; if above 84° F - forecast no.

Items 1, 2 and 3 must occur for a YES forecast.

(5) Height:

(a) Persistence.
(b) SBD stratus is 1,000 feet less than LAX.
(c) 200 feet higher for each degree of depression.
(d) Catalina Eddy causes lowering.
(e) Strong gradients mean higher stratus.
(f) Convergence - stratus will lift. Divergence - lower or dissipate.
(g) If the maximum temperature is expected to be higher than yesterday, forecast the ceiling lower (and vice versa).

(6) Timing:

(a) Lower ceiling comes in later.
(b) Higher ceiling comes in earlier.
(c) Burn off rate is approximately 300 feet/hour.

(7) Miscellaneous:

(a) If the stratus layer is 3,000 feet thick, it will stay all day.
(b) If drizzle is reported, the thickness is more than 2,000 feet.
(c) During the stratus months, (April through June), one can be pretty sure that no stratus will occur when the 500 mb height exceeds 5900 meters and the 850 mb height exceeds 1510 meters. (See Climo Study for Norton - Zeldin, 1970)

b. Visibility restrictions at Norton:

(1) Factors which lower the visibility at Norton:

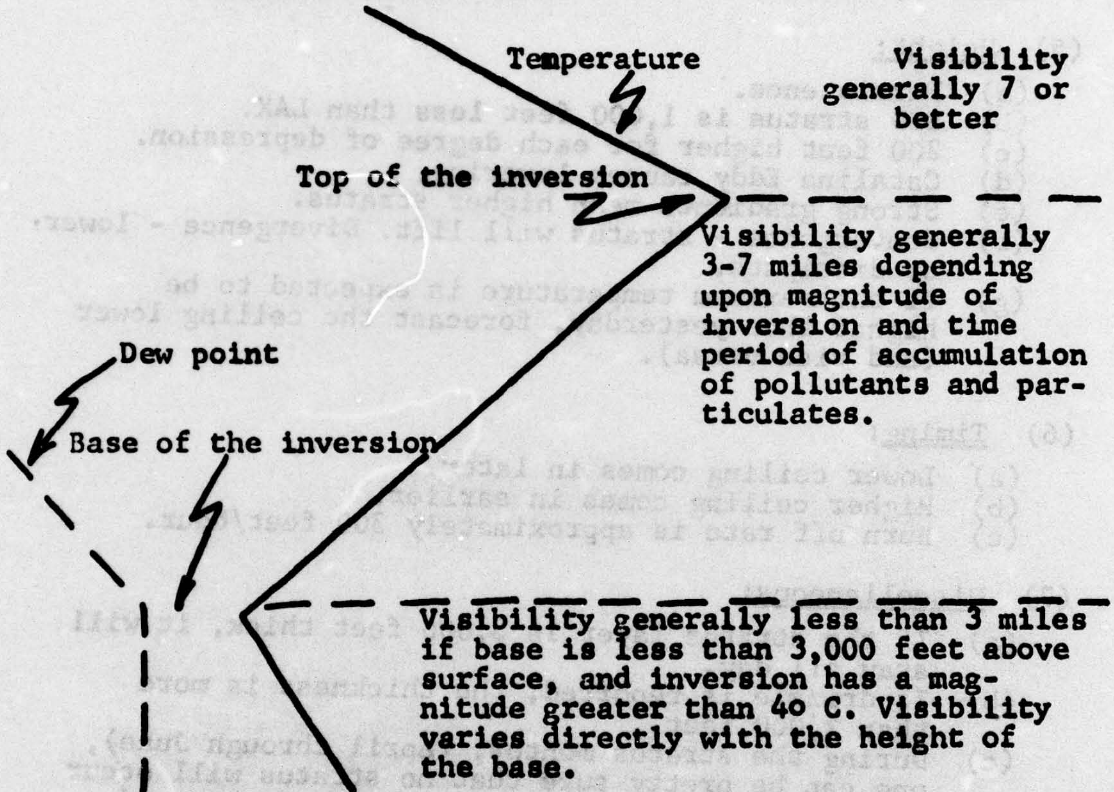
(a) The base of the inversion is lower at SBD.
(b) The intensity of the inversion is greater.
(c) The dew point is higher.
(d) Greater concentration (accumulation) of pollutants.
(e) Advection from upstream stations; SBD visibility as follows.

1. During certain periods, the minimum visibility upstream provides a basic limit for SBD.

2. The visibility at Norton during 04-09L undergoes a noticeable morning effect. (Lower)

3. If there are reduced visibilities upstream and any means for advection, the SBD visibility will lower

(f) Consider the following idealized model of an LAX Basin inversion



(g) Inland progression of the inversion base late night or morning. Inversion is normally below SBD. (<u>Not</u> the same as the sea breeze front). Just because the inversion reaches ONO does not mean it will get to SBD. The characteristics of an inversion passage are as follows.

1. Occurs between 0000L and 1500L.
2. Visibility lowers, sometimes suddenly and drastically.
3. Increase in dew point.
4. 0000-0700L passage - fog or stratus form.
5. 0700-1500L passage - principle restriction is haze and smoke. Visibility decreases during time of day it normally increases.

6. Less than normal temperature increase for the next hour or so.
7. Passage generally indicates lower visibility for at least the next 24 hours.
8. Requirements for passage include any parameter change which will allow inversion to rise.

(h) Passage of a sea breeze front: Sea breeze front is an onshore low level, offshore aloft convection type circulation cell which becomes established as the result of differential heating over land and sea surfaces. It generally appears at SBD as:

1. An obvious change toward lower visibility. (Haze and/or smoke between 1300L and 2100L)
2. Prevailing 6 mile visibility must decrease by a reportable value from the previous hour and remain so for at least one hour.
3. Occurs with a westerly wind.
4. Factors precluding passage of sea breeze front.

   a. Any component of wind from the east.
   b. Cold front passages.
   c. Rain.
   d. Thunderstorms at SBD.
   e. Summation of the surface pressure gradients LGB-DAG plus SBD-VCV plus SAN-LAS is greater than 16 mb or less than minus 7.5 millibars.
   f. No inversions exist at LAX below 5,000 feet.

5. Sea breeze front will pass when:

   a. Top of the subsidence inversion over LAX at 14Z must be between 1,000 and 4,000 feet MSL.
   b. Magnitude of the inversion must equal or exceed 4°C.
   c. Visibility upstream from SBD must be less than 3 miles during the morning.
   d. Westerly sea breeze must occur in the afternoon.

NOTE: The sea breeze is not dependent upon the base of the inversion. Sea breezes have occurred when the inversion base is above and below Norton and with or without accompanying stratus. (For further information, see Rasmussen, 1968, 69 and 74).

c. **Santa Ana Wind Forecasts:**

Anticyclonic Curvature

(1) 24 Hour indicator: Strong ridging at 500 mb along California - Washington coast. (Types C and D). Strong high pressure at surface moving into Great Basin.

(2) 3-6 hour indicators	**Critical**
a. 10,000 foot winds at SBD	32-06°/15 kt
b. Isobar orientation	east-west
c. Delta P for WMC-LAX	$>$10mb
d. 700mb temperature VBG-LAS	$\geqq 4^\circ$ C.
e. Delta P for TPH-SBD	$>$ 7mb
f. Delta P for VCV-SBD	$>$ 3mb
g. Temperature at SBD-VCV	$> 5^\circ$ F.

Cyclonic Curvature

(1) 24 Hour indicators:

a. 500 mb 12 hour delta temp at WMC	$< -5^\circ$C.
b. Progged closed low at surface in southern Nevada or Arizona. (Type C and certain Type D, E_g)	

(2) 0-12 Hour indicators	**Critical**
a. 700mb temperature SAN-WMC	$\geqq 12^\circ$ C.
b. Cold FROPA	85% of time
c. Lower pressure east of SBD	100% of time
d. 10,000 foot wind speed at SBD	33-05°/15kt
e. Trough passage at SBD	moving
f. Delta P for VCV-SBD	Flips from - to +
g. Isobar orientation	north-south

NOTE: Keep in mind that Santa Ana winds at Norton can be very fickle and erratic. They may blow from the north at 40 knots for one hour then become light and variable for the next hour only to return to 40 knots later on. In addition to the turbulence hazard associated with the Santa Anas, a low level shear west of the airfield during the nighttime hours is usually encountered. In a true Santa Ana, the winds at the surface at Norton will become calm to 5 knots at night. However, a strong jet of 30-50 knots will persist anywhere from 200 to 1,000 feet above the surface. (See also Rasmussen, 1971)

EDWARDS AFB (EDW) FORECAST GUIDE

1. UNITS SUPPORTED: AFFTC, Test Pilot School; AF Plant 42 (PMD). Occurrence of precipitation, surface winds greater than 30 knots and practically all other weather phenomena are significant depending on specific test parameters desired.

2. PHYSICAL DESCRIPTION AND LOCATION: Edwards Air Force Base is located in the western Mojave Desert sixty miles north of Los Angeles. The base is quite large, nearly 20 miles north-south and 35 miles east-west with the base complex nearly in the center at Rogers Dry Lake. Edwards was located to take advantage of the very level surfaces of Rogers and Rosamond Dry Lakes plus the isolated nature of the terrain for testing and development of experimental aircraft.

The Mojave is true desert, flat and sandy with typical cacti, scrub and no open water. The low Garlock Range lies north of the base a few miles, but the hills rise only 500 feet at the most. More significant are the Tehachapi Mountains to the west and northwest(35 miles west with peaks to 8,000 feet), and the San Gabriel Mountains in the southern sector (30 miles south with peaks to 10,000 feet). The desert changes little in character moving to the east, but several large mountains oriented in a line running north-south lie to the north and northeast at 30 miles from the base.

There are many small settlements in the general area of Edwards, but most notable are cities to the south and south-west towards Los Angeles. Palmdale and Lancaster have a combined population of over 40,000. Pollution moves out into the desert on southwest flow producing haze which is almost continuous, though actual visibility restrictions are rarely significant at the base itself.

Field elevation is 2,302 feet, and the runway is oriented 04-22.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The Tehachapi Mountains to the west and the southern Sierra Nevada to the northwest affect Edwards in many ways. First, orographic uplift and subsequent dynamic descent dry out almost all cold fronts moving in from the northwest and weaken them so much that it is difficult to even observe their passages. At most, category D ceilings and light showers may be expected. Winds shift erratically from southwest to northwest as the fronts move through. Second, winds become a complex forecasting problem, for both speeds and directions may vary greatly in time and space. Winds with speeds to 40 knots from southwest to northwest occur with most fronts moving from that direction. Third, occasional summer air mass thunderstorms develop almost exclusively in the mountains even over the relatively small ranges scattered over the Mojave Desert. A few cells may advect over Edwards late in the


EDWARDS
EDWARDS AF AUX NORTH BASE
GORMAN
LAKE HUGHES
ROSAMOND
FOX
QUARTZ HILL
DESERT
HAWKINS
HANSEN
VORTAC PALMDALE
HELENDALE
EL MIRAGE
CRYSTAL
APPLE VALLEY
TACAN GEORGE
Daggett
BARSTOW-DAG
SOGGY DRY LAKE
Lucerne Valley
35°
118°
VOR/DME VAN NUYS
SANTA SUSANA
WHITEMAN
LOS ANGELES
EL MONTE
VOR/DME SANTA MONICA
HAWTHORNE
COMPTON
VORTAC LOS ANGELES
FULLERTON
NAS LOS ALAMITOS
VOR RIVERSIDE
TACAN MARCH
MARCH
ONTARIO
CAUTION
Big Bear City
San Jacinto
HEMET RYAN
VORTAC SEAL BEACH
Newport Beach
VOR SANTA ANA
Laguna Beach
SAN PEDRO CHANNEL
SANTA CATALINA ISLAND
SANTA CATALINA
VOR-TACAN-NDB MARINE EL TORO
CAPISTRANO
San Clemente
Temecula
CALIFORNIA
LAKE RIVERSIDE
BUTTERFIELD
OCEANSIDE
117
TACAN-NDB SAN CLEMENTE ISLAND
GULF OF CD
33°
SANTA CATALINA
Encinitas
TACAN-NDB NAVY MIRAMAR
SAN DIEGO
SAN DIEGO

afternoon. Lastly, the ranges to the south block much of the pollution from Los Angeles. In general, the visibility is reduced only south of Edwards.

b. Transient Controls: Fronts moving from the northwest either arrive dry or produce brief category D ceilings and light showers. Winds are always gusty out of the west. If a surface low develops in Nevada, persistent northwest winds gusting to 40 knots will occur until the low moves well east.

In frequently in winter, upper air lows lie off the southern California coast (Type E_s) and/or move through the Edwards area. Associated surface systems account for instances of heavy precipitation. Edwards can have overrunning conditions and intermittent category B stratus in precipitation without significant visibility reduction.

In summer, southerly or southeasterly flow aloft may draw in moisture from the tropical Pacific or Gulf of Mexico. Middle clouds occasionally lower to category D in the afternoon, while high-based thunderstorms develop in the mountains. Showers are always light if they occur at all. Cells tend to move with the 700 mb flow.

4. SYNOPTIC TYPES AND FORECAST RULES:

a. Type B, Winter: "Zonal Flow": Ridging over the Far West eliminates most forecast problems except for winds and weak frontal passages. Active fronts are rare and are preceded by a few hours of category D middle clouds which are extremely difficult to time. If the Great Basin High is present, winds will be variable tending to be northeast and occasionally gusting to 25 knots mainly late at night and in the morning.

b. Type C, Winter: "California Low": The upper level low over the area and general northwesterly flow increase northeast surface winds, since a strong high is likely in the Pacific Northwest.

c. Type D, Winter: "Colorado Low": Migratory lows move through northern California or Oregon and redevelop in Nevada usually northeast of Edwards. Fronts observed at Edwards are essentially the same as active Type B. Strong northwesterly winds persist until the surface low is well to the east.

d. Type E_s, Winter: "Gulf Wave": The upper level low off southern California is associated with overrunning conditions in the deserts when there are active fronts. Scattered to broken middle clouds and light showers occur when the upper low is well west. But as the low and surface system move eastward to the coast, category D clouds with intermittent B category nimbostratus and rain occur. Pre-frontal winds are southeasterly as with other fronts. (Types B and D).

5. SEASONAL FORECAST RULES: None

GEORGE AFB (VCV) FORECAST GUIDE

1. UNITS SUPPORTED: 561st TFS (F-105), 4435 TFRS (F-4), 563rd TFTS (F-4, F-105), 434th TFS (F-4), 562nd TFS (F-4), 20th TFTS (F-4), 21st TFTS (F-4), 84th FIS (F-106). Training minimums are 300 feet and/or 1 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: George AFB is located in the Mojave Desert six miles northwest of Victorville, California and 35 miles north-northwest of San Bernardino. Cajon Pass, a very important gap in the San Gabriel - San Bernardino Mountains, lies 20 miles south. The San Bernardino Valley and the Los Angeles Basin lie on the other side of the pass.

The San Gabriel-San Berhardino Mountains are oriented east-west and are as close as 20 miles south-southeast through southwest. Most peaks are 6,000 feet high with a few to over 10,000 feet. Mt. San Antonio (10,800 feet MSL) is 25 miles southwest. Cajon Pass lies at 4,300 feet MSL.

The desert elevation of George is about 2,800 feet and gradually lowers to the northeast. Several desert mountain ranges close by rise as high as 4,500 feet. One prominent one lies 5 miles northeast of the base. The Mojave is true desert with just sand and scrub. The intermittently flowing Mojave River passes George but is not a forecast problem.

Pollution sources locally include two cement plants a few miles northeast-southeast and smog filtering through the Cajon Pass. There is almost always some haze particularly in the summer. Restriction below category E is rare, however.

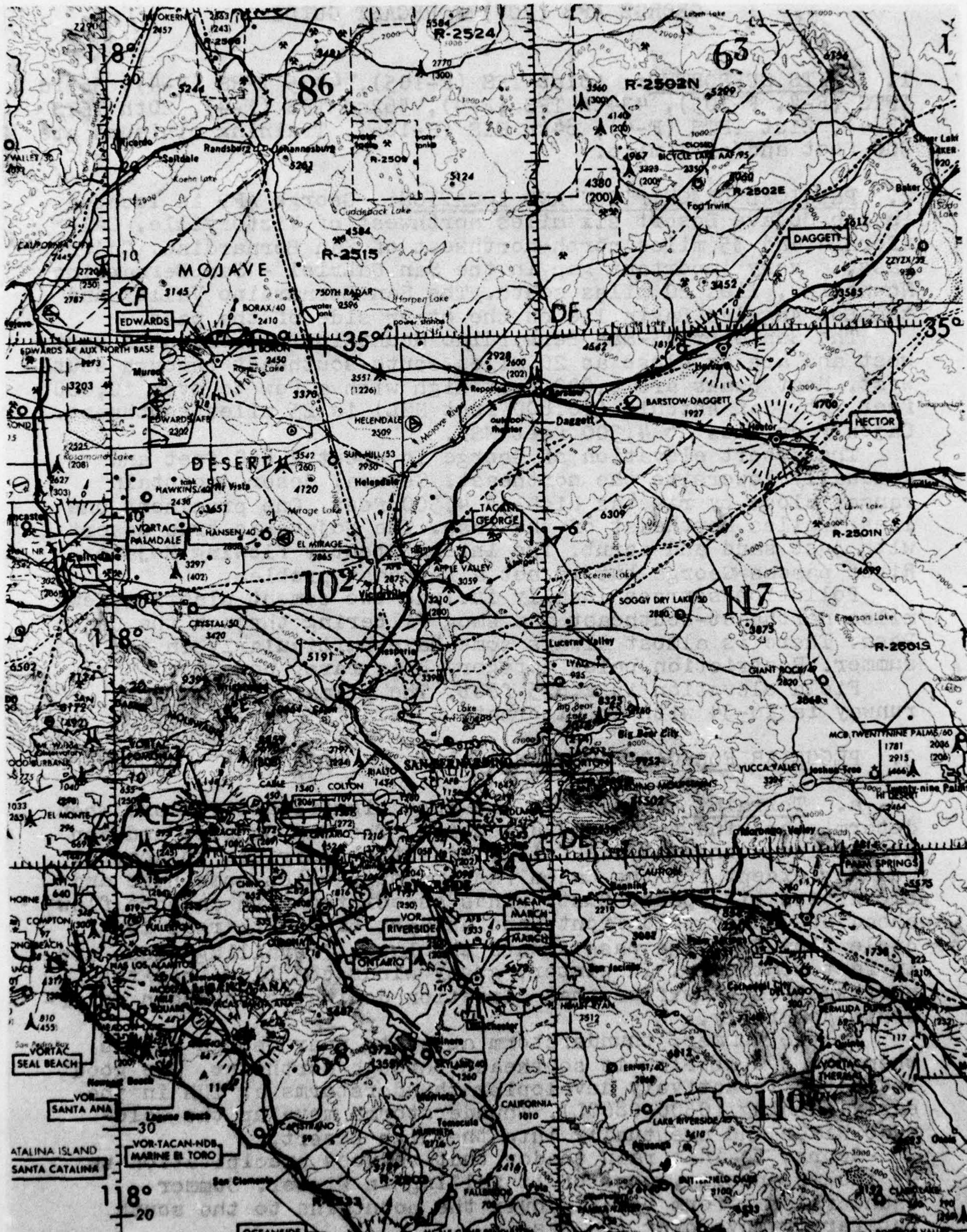
Field elevation is 2,875 feet. The primary instrument runway is 16-34 with an alternate 03-21.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Terrain is the most significant feature when determining wind speed and direction. The San Gabriel and San Bernardino Mountains are fairly effective barriers to coastal weather except for the Cajon Pass through which some haze and cloudiness will pass. Gusty winds associated with onshore flow ahead of winter cold fronts and as part of the thermal low cycle blow from the pass toward the base. Prevailing winds are in fact southerly. In winter, gusty winds can blow from the northwest if flow from that direction dominates southern California generally.

In the summer, thunderstorm activity near George occurs when the 500 mb flow is southeast through northeast. One good indicator is actively developing thunderstorms at YUM in the early morning (0500-0800L). Thunderstorms move up the Colorado River and eventually into the High Desert.

George is in a rain shadow that reduces precipitation to 4½ inches anually, most of it falling in Winter. Summer thunderstorms form readily over the mountains to the south but rarely move over the base.



R-2524
86
63
R-2502N
R-2502E
R-2505
Randsburg
Johannesburg
Cuddeback Lake
Fort Irwin
R-2515
MOJAVE
DESERT
EDWARDS
EDWARDS AF AUX NORTH BASE
EDWARDS AFB
Harper Lake
DAGGETT
BARSTOW-DAGGETT
HECTOR
HELENDALE
Helendale
VORTAC
PALMDALE
EL MIRAGE
TACAN
GEORGE
APPLE VALLEY
Victorville
Lucerne Valley
Lucerne Lake
SOGGY DRY LAKE
R-2501N
R-2501S
Emerson Lake
102
117
117°
118°
35°
Big Bear City
YUCCA VALLEY
MCB TWENTYNINE PALMS
SAN BERNARDINO
RIALTO
COLTON
EL MONTE
COMPTON
PALM SPRINGS
VOR
RIVERSIDE
MARCH
ONTARIO
NAS LOS ALAMITOS
58
110
VORTAC
SEAL BEACH
VOR
SANTA ANA
VOR-TACAN-NDB
MARINE EL TORO
SANTA CATALINA
CATALINA ISLAND
Newport Beach
Laguna Beach
San Clemente
OCEANSIDE
MCAF CAMP PENDLETON
FALLBROOK
Temecula
CALIFORNIA
THERMAL
BORREGO VALLEY

The forecasting of gusty winds per se is not a problem, but the actual direction and speed when other stations have winds of 30 knots is difficult to determine. Forecasters should be aware of the terrain features in the desert. The Shadow Mountains to the west through northwest deflect strong northwesterly winds around VCV and usually prevent winds from gusting over 34 knots.

b. Transient Controls: Both migratory pressure systems and local effects are important.

(1) Stratus Regimes: Stratus can enter the desert through the Cajon Pass but does not in Summer. The thermal low cycle does draw in haze and smog when the coastal areas are covered with stratus and when the winds at George are southerly. Visibility may be reduced to 7 miles but very seldom is worse than that. In Winter, stratus and fog do not cross the mountains to the south unless associated with an organized system. Stratus that does enter by the Cajon Pass, but is not associated with a low pressure system off the West Coast, will rarely affect George. Heating through compression rapidly dissipates most stratus coming through the pass. In the Spring and early Summer when the marine inversion rises to above the mountain tops, spill-over of moist air occurs. This is accompanied by a rise in dew-point, strong southerly surface winds and a noticable leveling off of afternoon temperatures. In such cases, scattered stratocumulus clouds are apt to occur at George.

(2) Migratory Lows: Southwesterly flow aloft ahead of an upper level trough, when coupled with pre-frontal surface winds along the southern California coast, presents a special problem. Category D stratocumulus with D visibility in blowing dust (when winds exceed a steady 30 knots) occur especially in mid-afternoon. Active fronts which produce wide-spread precipitation along the coast may lower conditions late in the day to category B or C clouds with D or even C visibility in dust and light showers. Winds may gust to 35 knots but rarely exceed 45 knots. When surface changes are lacking to determine frontal passage, a wind shift at Sandberg (SDB: elevation approximately 5,345 ft) will indicate that a front has moved east of that station.

(3) Offshore Upper Level Lows: As such lows cause as a minimum showers along the coast, expect intermittent category D ceilings and gusty winds in the afternoon. If one of these lows moves eastward and passes overhead, ceilings are rather persistently D with light rain. As the trough passes, winds gradually turn to the northwest but rarely gust.

(4) Santa Ana Conditions: George is north of the mountains, so northeast winds of 25 knots are the rule. The Santa Ana, howevermis a serious condition on the south side of Cajon Pass.

(5) Summer Tropical Air: During southeasterly moisture surges from the Gulf of Mexico or southerly from Baja, some thunderstorms may drift off the mountains towards George in the afternoon. Few reach the base.

4. SYNOPTIC TYPES AND FORECAST RULES:

a. Type B, Winter: "Zonal Flow": The forecast problem involved here involves winds associated with the weak northwesterly cold fronts that occasionally pass through the area. Pre-frontal winds will be southerly, gusting to 25 or 35 knots in the afternoon. Little weather will leave the mountains. Post-frontal winds are lighter and out of the west-northwest.

b. Type C, Winter: "California Low": If this system remains over California, it is a good indication that George will receive a variety of weather. Variable cloudiness throughout the day and instability showers are likely. As short waves move through the desert, ceilings may be as low as 1500 feet with strong southerly winds. When a surface low has developed off the coast of southern California and associated with a closed low at the 500 mb level, southern California will have its extreme weather conditions. Occasionally, as many as three closed low centers will develop at the surface west of San Diego. The greater the vertical development associated with the surface low, the greater the effect the system will have on the Mojave Desert. Skies over the desert will become broken to overcast with ceilings variable between category B and low D with periods of rain or snow (determined by the amount of cold air advected into the system).

c. Type D, Winter: "Colorado Low": Migratory lows moving into Nevada often deepen. Pre-frontal winds may be south to southwest and gusting over 35 knots in the afternoon (become 25 or less at night). Category D clouds and lowered visibility in dust are typical as the front reaches the coast. Post-frontal winds remain out of the southwest and continue to gust for 24 hours.

d. Type E_S, Winter: "Gulf Low": The upper level low off southern California is not much of a problem until it moves eastward over the area. Conditions are as in 3b(3) above.

e. Type B, Summer: "Low Amplitude Flow": Summer haze is frequent but usually presents no problem unless extensive on-shore flow and coastal stratus occur.

5. SEASONAL FORECAST RULES:

a. Wind direction will vary 90°-120° from Edwards due to terrain effects.

b. A surface temperature inversion exists at least 3/4 of the year between sunset and 0900 the following morning. The surface wind is a light dry southerly flow which prevents fog.

REGION 10

DESERT SOUTHWEST FORECAST GUIDES

Nellis AFB	LSV
Williams AFB	CHD
Luke AFB	LUF
Davis-Monthan AFB	DMA
Holloman AFB	HMN

NELLIS AFB (LSV) FORECAST GUIDE

1. UNITS SUPPORTED: 57th Ftr Wpns Wg (F-111, F-4, A-7, T-38) 474th TFW (F-111). Indian Springs (HU-1B). 500 and/or 1 mile are special amendment criteria.

2. PHYSICAL DESCRIPTION AND LOCATION: Nellis Air Force Base lies eight miles northeast of Las Vegas in extreme southern Nevada. The base is in the northeast portion of the rectangular Las Vegas Valley which is approximately 30 miles on a side and open in several directions by wide passes. This is true desert country, very dry and barren, though open water exists at Lake Mead which is 20 miles southeast of the base.

The valley floor is approximately 2,000 feet in elevation. Thirty miles to the west is the Spring Range averaging 8,000 feet. The northwest border of the valley is one of the wide passes. As close as 5 miles to the north is the Sheep Range topped by 9,720 foot Sheep Mountain, 25 miles away. Another wide pass exists along the northeast border of the valley close to Nellis. Within 25 miles to the east and southeast are the Muddy Mountains. The closest peak is Sunrise Mountain (4,054 feet) which lies as close as 3 miles and generally parallel to the principle runway.

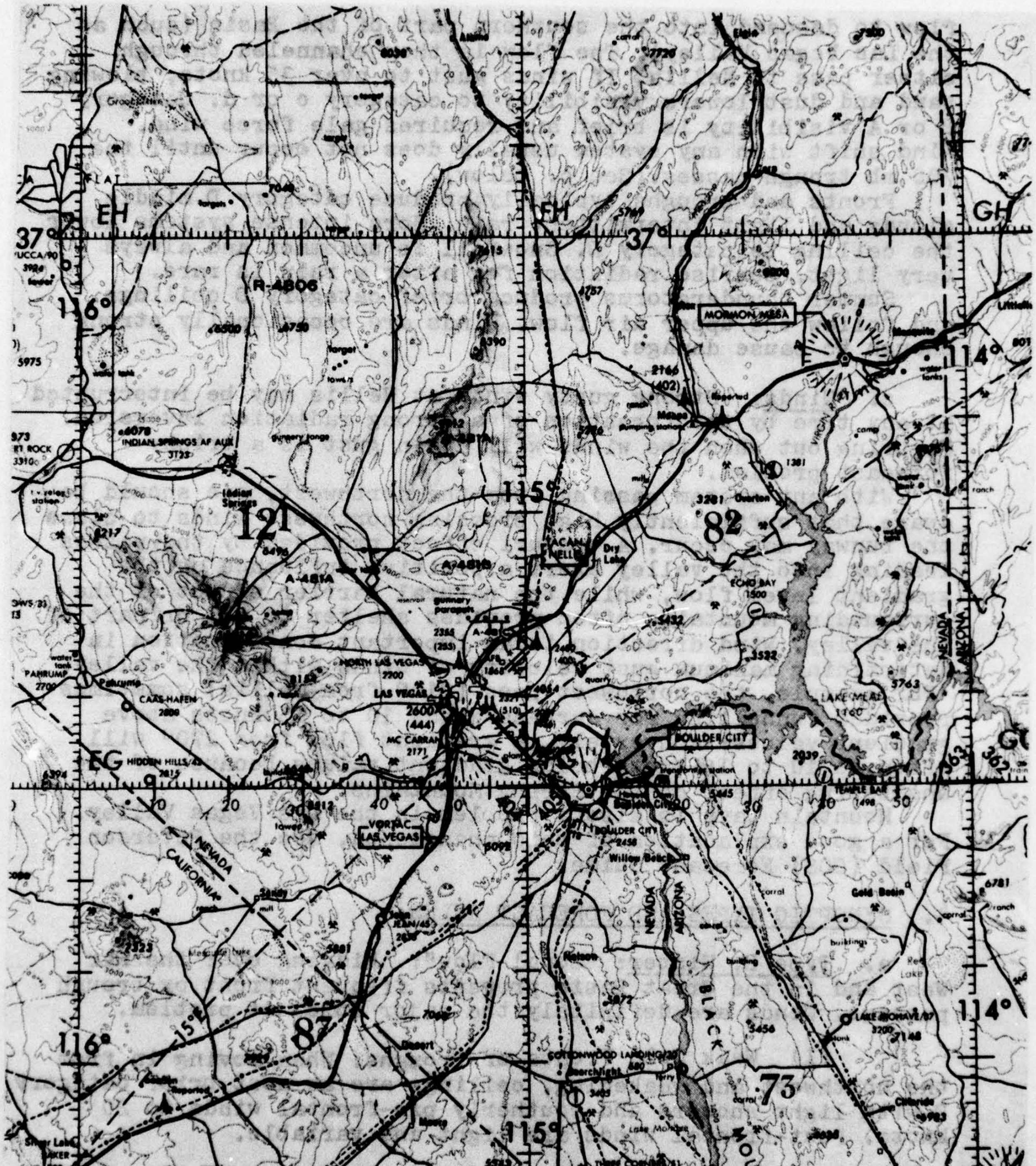
To the southwest lies the urbanized portion of the valley. The Las Vegas area is a sprawling suburb with a dense inner city core. North Las Vegas lies just west of the base. At present, the only pollution source is urban, but the valley configuration is capable of trapping pollutants when there is a low inversion. Field elevation is 1,868 feet, and the runway is oriented 03-21. The casinos are eight miles to the southwest.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The major passes to the northwest and northeast funnel low level winds and are thus well worth knowing for local forecasting. The runway orientation takes advantage of flow from the south through Las Vegas and also the pass to the northeast. Prevailing winds tend to be southerly in Summer and northeasterly in Winter. Furthermore, gradient winds during calm mornings allow mountain breezes off Sunrise Mountain to routinely affect Nellis. Wind speeds are generally less than 10 knots.

The floor of the valley as well as the surrounding mountains is sparsely covered with sage brush, mesquite and oreosote bush. There is very little natural soil binding the grass, and unvegetated sand is dominant on the valley floor, easy prey for winds funneling through the passes and the downrush from high level summertime thunderstorms.

b. Transient Controls: Winter fronts and troughs may be preceded by gusty south winds and followed by even stronger northwesterly winds. This is particularly true when a strong high pushes into the Great Basin to the north allowing the



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INDIAN SPRINGS AF AUX
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82
87
73
PAHRUMP
NORTH LAS VEGAS
LAS VEGAS
MC CARRAN
BOULDER CITY
ECHO BAY
LAKE MEAD
TEMPLE BAR
VORTAC LAS VEGAS
NEVADA
CALIFORNIA
ARIZONA
BLACK
MOUNTAINS
COTTONWOOD LANDING
Searchlight
Gold Basin
LAKE MOHAVE
HART MINES
GOFFS
EG
EF

flow to descend into the southern part of the Basin (such as the Las Vegas Valley). The flow is then channeled through either pass to Nellis. If winds gust to over 35 knots, blowing sand and dust lowers visibility to category c or d. Category B or A visibility is brief and requires gale force wind. Wind shift with any system usually does not occur until the 700 mb trough passes.(See c. below).

Fronts and troughs typically produce category D middle clouds and light intermittent rain. More intense systems lower the ceiling to category D. Snowfall is uncommon and always very light. Sunrise radiation fog after a rain is rare.

Summer thunderstorms produce brief category D ceilings and follow the upper air flow. Winds are occasionally strong enough to cause damage.

c. Winds: Strong gusty winds at Nellis may be interrupted at any time by the formation of a strong radiation inversion. Figuring out when the winds will again gust is a tricky forecast problem.

With any system passing from the northwest, one should be aware that sufficiently high crossing northwest winds to close the runway may occur. A venturi effect provided by the passes leading into the valley exert a positive influence on the gradient level flow, while the natural barrier effect of the surrounding mountains often provides shelter to all or part of the valley. Wind direction is an important consideration in determining maximum gust velocity of winds within the valley. For example, the northwest pass (310° from Nellis) sometimes provides funnelling for surface winds 10 to 15 knots above gradient values; conversely, a gradient flow from 270° will often be 10 to 15 knots below gradient values because of the sheltering effect of the Spring Mountains.

Mountain wave is also a problem in the Las Vegas Valley. For a good explanation of this phenomenon, see the Peterson Field (COS) Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES:

a. Type B, Winter: "Zonal Flow": Ridging over the Far West and in the Great Basin prevents frequent front or trough passage. Winds are definitely the major forecast problem.

(1) Weak Cold Fronts or Troughs: When moving in from the northwest and weakening, ceilings are at most brief category D with light showers and southerly pre-frontal winds to 20 knots. Post-frontal winds are light and variable.

(2) Fronts Accompanied by Strong Pressure Gradient: On occasion, a thermal low may lie in the Nellis area and may become dynamic as a front approaches. Pre-frontal southerly winds may reach 35 knots and raise dust. Post-frontal winds are definitely northwesterly and stronger.

(3) Developing fronts and troughs: Occasionally systems develop originally over Nevada (not Type D) north of Nellis. A cold front will develop to the southwest as the wave moves into Utah. Category D ceilings and showers occur on the front with possible intermittent periods of category C clouds. Winds are strongest when the wave is developing and fall off after frontal passage.

b. Type C, Winter: "California Low": The position of the upper level low is apt to be right over or just south of Nellis. If so, instability showers remain over the mountains. If the low is to the southwest of the station, variable ceilings occur with showers. The original setting up of this type may bring a moderate cold front through the station.

c. Type D, Winter: "Colorado Low": Migratory lows entering central or northern Nevada generate more intense cold fronts than Type B(3). Expect category C clouds and rainshowers (rarely snow) with gusty pre-frontal southerly winds. Post-frontal winds remain strong.

d. Type E_s, Winter: "Gulf Wave": An upper level low off southern California may allow troughs and associated middle clouds into the Nellis area with occasional category C ceilings and light rain until the trough passes. Pre-trough winds are light and variable. Ground fog will only develop the following morning if substantial rain falls.

e. Type B, Summer: "Low Amplitude Flow": This type poses no problem unless air mass thunderstorms should happen to pass over the station. When the upper flow is southeasterly, this can occur. Thunderstorms produce D category ceilings and C category visibility in blowing dust.

5. SEASONAL FORECAST RULES:

a. See 5WWg Technical Notes 71-2 and 72-3.

b. In the Type E_s regime, the entire low may move eastward across the area. A front will pass on the surface prior to the trough. Expect steady rain with accompanying B category ceilings until the system is east of 110°W. (This situation creates the worst weather at Nellis).

WILLIAMS AFB (CHD) FORECAST GUIDE

1. UNITS SUPPORTED: 82nd Flying Training Wing (T-37, T-38), 425th TFTS (F-5).

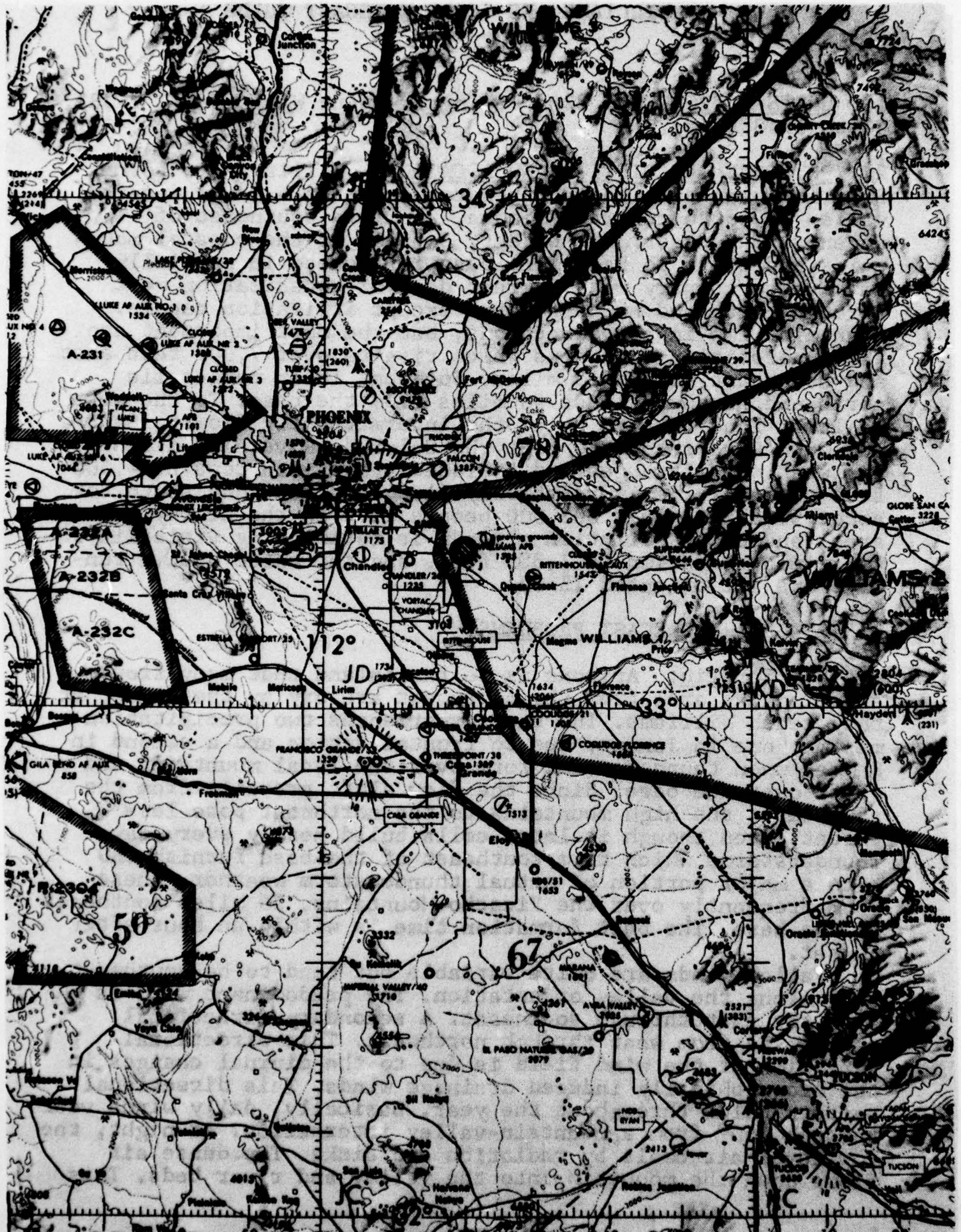
2. PHYSICAL DESCRIPTION AND LOCATION: Williams Air Force Base is located on the northeastern side of a large desert valley in south central Arizona, 25 miles southeast of Phoenix. The desert, in effect, extends to the coastal mountains and south to Baja. The base is located in partially cultivated country with a great deal of urbanization west through north and no open water except irrigation canals. Mountains lie in all directions, but the most important are the Superstition Mountains which rise to over 7,000 feet east and northeast beyond 15 miles. Somewhat lower ranges lie north and northwest past 30 miles from the base. To the west is lower land through which the intermittently flowing Salt and Gila Rivers move to meet the Colorado River 100 miles to the west. Small ranges and isolated peaks with tops to 4,500 feet or lower lie in relatively flat land west and south for about 50 miles. Over 600,000 people live in the nearby Phoenix area, and urban pollution already is restricting visibility.

Field elevation is 1,385 feet, and the three active runways are all oriented 12-30.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Arizona is so far inland that many fronts entering the area from the northwest are dry by the time that they reach Williams. The base experiences two precipitation maxima; one in January due to frontal action and a second in Summer when thunderstorms form over the local mountains and drift over the base. Since the flow aloft prevails from the southeast, the high mountains to the northeast pose less threat, even though isolated cells build nearly every day. Thunderstorms which form southeast of the base furnish CHD with a major portion of actual thunderstorm weather. These form frequently over the Picacho Mountains, 35 miles southeast of the base. The best formation time is within an hour after sunset.

Valley winds are quite variable but tend to be southeasterly along the valley orientation. The predominant wind is from the east through southeast. A secondary directional maximum is from west through northwest. This directional variation of the wind field is due to the diurnal changes in the orographically induced drainage winds. This directional pattern holds throughout the year. Basically, daily winds veer through 360° from a mountain-valley interaction. At night, the low level air cools by radiation and sinks. The dense air flows down the mountain into the valley and river beds. This



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WILLIAMS
Chandler
CASA GRANDE
TUCSON
GILA BEND AF AUX

flow which continues well into morning is from the southeast from higher ground towards the Salt River. By early afternoon, the radiation inversion has been wiped out thereby decreasing the density of low level air. Return flow begins back up the valleys and is forced up the mountains through the evening hours. At Williams, this wind is out of the northwest. There are no seasonal wind regimes which compare in magnitude to this diurnal change.

b. __Transient Controls__: Dry fronts from the northwest are most common in the Spring and Fall. If they arrive at Williams in the afternoon, category D visibility in dust is possible for a few hours. Almost without exception, all detectable frontal passages occur during the months of October through March.

If the long-wave trough remains off the coast or far behind the surface position (TYPE C and E_s), the clouds and showers will remain in the local area for 24 hours or longer, and for longer yet in the mountains to the east. If the trough is quasi-stationary over Arizona, showery weather will persist until the trough moves.

Certain cut-off lows moving through Arizona may not seem to be associated with surface fronts. Middle cloud is extensive and remains until the trough passes. With an exceptionally deep trough, category C conditions are possible with heavier showers.

c. __Seasonal Weather__: This discussion is included primarily because the desert area bases are often taken for granted. Although specifically applicable to Williams, some of the following also includes factors affecting LSV, LUF, DMA and HMN.

During Summer (defined as July through mid-September), a thermal low at the surface is well established in southern California or western Arizona. Variation in the position of this low has no apparent effect on the weather at Williams. Migratory systems do not move through the area at all/ At upper levels, the westward extension of the Bermuda High dominates the circulation above 700 mb. The actual flow will be northeast through south depending on the orientation of the ridge. To some extent, the air mass in central Arizona becomes a modified maritime tropical type with dew points over 50°F. The Gulf of Mexico is a moisture source and so is the Gulf of California. Which source is actually primary is a matter for conjecture. The important thing is that the moisture is available in quantity, and combined with convection, orographic lift and nocturnal cooling, thunderstorms form in large numbers.

d. Thunderstorm Diurnal Variation, Development, and Movement: As one might expect, diurnal variations in thunderstorm activity occur in the desert like anywhere else. Observations at the ground and satellite pictures show that thunderstorms first form over the higher peaks (White Mountains, 125 miles ENE, and then northwest to the San Francisco Peaks near Flagstaff) during late morning or early afternoon. At that time, there is no activity in the desert valleys. As the afternoon progresses, the maximum activity moves southwest to the Mongollon Rim and then shifts to the lower mountains and foothills. This leads to the fact that activity in the Phoenix area is primarily nocturnal occurring from 1800-0000L in half of the cases.

Although thunderstorms from the mountains to the northeast occasionally affect Williams, the major portion of storms that move over CHD form over Newman or Picacho Peaks to the south-southeast.

In the desert, winds between 20,000 and 30,000 feet give the best direction of movement. A few more severe cells will appear to stand against the flow perhaps attributable to "movement by propagation".

If a thunderstorm does move over Williams, visibility may be reduced to near zero as the gust front passes through. Winds of 35 knots are relatively common, and higher gusts occur occasionally. Rain shafts are very isolated, and so the chances of significant rain at a point are slim.

e. Other Seasonal Weather: The synoptic features of Fall (mid-September through November) revolve around recession of the Bermuda High influence and increased troughing off the West Coast. This causes the thermal low to sink into Old Mexico as prevailing winds aloft turn from east to southwest. The only synoptic type that affects the desert during this period is Type C which carries with it widespread precipitation and clouds. Other fronts are primarily dry.

Increased amplitude of long waves and formation of the Great Basin High dominate the winter season (December through March). The predominant air mass changes over to maritime polar in the mean with occasional intrusions of continental air. All synoptic types are experienced during these months with an increased number of frontal passages averaging one per week.

April through June experience a sudden decrease in amplitude of long waves and a return to dominance by the Bermuda Ridge by the end of June. Type C is rare during the Spring, so virtually all fronts that approach the Williams area are dry.

4. SYNOPTIC TYPES AND FORECAST RULES:

a. Type B, Winter: "Zonal Flow": Ridging over the Far West eliminates most frontal passages from the desert areas. An active system may raise some dust if it passes during the

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FORECAST GUIDES USED FOR THE CENTRALIZED TERMINAL FORECAST PROG--ETC(U)
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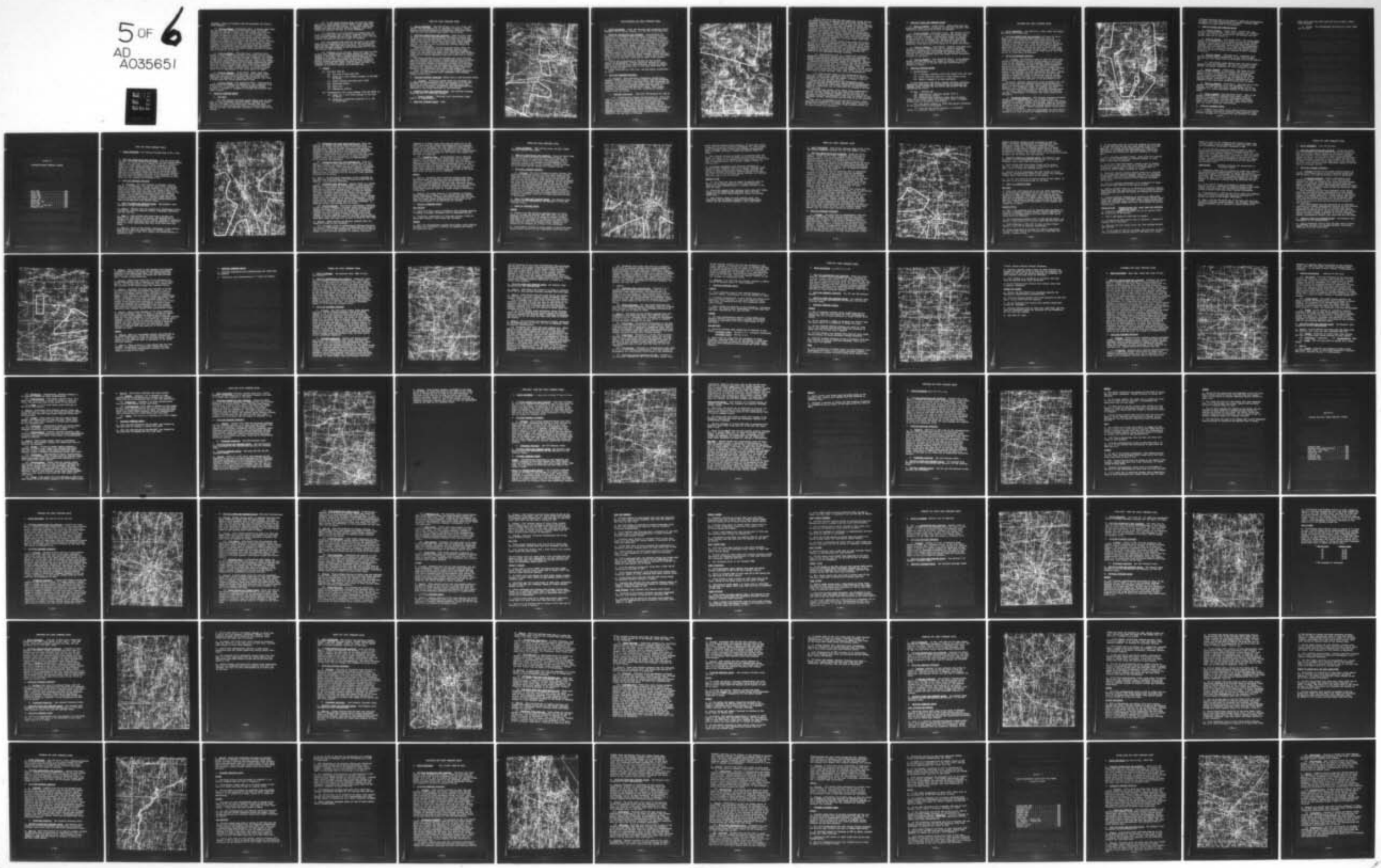


afternoon. Gusts to 30 knots from the northwest are typical after passage.

b. Type C, Winter: "California Low": A strong upper level low usually lies northwest of Williams. When the trough deepens and becomes a closed low, the weather type has its greatest effect. If a front moves out of the closed low circulation which is likely this far east, record precipitation and very low ceilings occur which continue until the upper system moves to the east of the station. Type C can become more north-south oriented such that the trough position lies at 105-115°W. In this case, a front is likely to pass Williams. It is marked by a few cumulus clouds when passing during the daytime and strong gusty winds. The pattern is much less severe because the major trough position is either over Williams or to the east.

c. Type D, Winter: "Colorado Low": Migratory Lows moving through Nevada, well north of Williams, usually push active mP fronts into the CHD area when supported by a strong trough aloft. Category D middle clouds or cumulus will occur if the front moves through during the day. Rain is not likely. Pre-frontal southerly winds and following northwesterly winds may gust to 25 knots and raise dust. Skies clear completely after the front, though clouds persist in the mountains to the east. As with Type C (second part), no clouds or gusty winds will be experienced if the front passes at night.

d. Type E, Winter: "Gulf Wave": Upper level lows typically move eastward from the ocean off southern California and pass just north of Williams. Fronts may not be indicated in analysis. In general, expect weather like Type D rather than the closed system Type C case.

e. Type B, Summer: "Low Amplitude Flow": Thunderstorms occur locally as outlined in Section 3c. and d. Category A or B visibility is possible with initial downrush lifting quickly to category D. Category D ceilings are possible with light showers.

5. SEASONAL FORECAST RULES:

a. All Year

(1) The ordinary CHD wind regime begins late at night with a 5 knot southeast mountain breeze, changing to southwest at 5-10 knots a few hours after sunrise. The wind continues to veer becoming northwest at 10 knots during the heat of the day, then variable, northerly or near calm in the evening.

(2) If the early morning winds are from the southeast with a speed greater than 10 knots, gusty winds will dominate the area by mid morning. If the winds during the morning are from the west or north quadrants, then gusty winds will dominate the area by early afternoon.

(3) Category C or D visibility in blowing dust can occur in steady winds over 20 knots. Gradient winds with a 3 mb gradient between CHD and Blythe (BLH) may gust from the south to 30 knots if the low is west of Williams.

(4) The surface wind speed at the time of the inversion breaking temperature will be 75% of the average wind speed between 7,000 feet and 10,000 feet. (If the winds on the 1200Z TUS RAOB between 7M and 10M are from 135° to 225° and greater than 20 knots).

(5) Normally in any one day, there will only be about an hour when thunderstorms are close enough to affect the weather at the base. After a thunderstorm passes in the late afternoon or evening, it is usually safe to forecast no further activity for that period. An exception to this is diurnal morning thunderstorms followed by late afternoon activity that same day. After a day of heavy activity, the tendency is for less activity the following day.

b. <u>Winter</u>

(1) Fog will form if:

(a) The $T-T_d$ is less than 2^oF.

(b) There was a cold frontal passage in the past 24 hours.

(c) Rapid clearing occurred after 0700Z.

(d) Saturated ground.

(e) Calm wind.

(f) Widespread puddles.

(2) Stratocumulus will occur between 1700 and 2200Z if:

(a) There was a cold front passage in the past 24 hours.

(b) There was a radiation inversion to 4, 000 or 5,000 feet.

LUKE AFB (LUF) FORECAST GUIDE

1. UNITS SUPPORTED: 58th TFW (F-104, F-4, F-5, F-15), ANG KC-97, Briefing Service to Ft. Huachuca (U-8,OV-1), 302nd Special Operations Squadron (helicopters). Additional amendment criteria are 200/500 feet and/or 3/4//2 miles.

2. PHYSICAL DESCRIPTION AND LOCATION: Luke Air Force Base is located 15 miles west-northwest of Phoenix, Arizona and 45 miles in the same direction from Williams Air Force Base (CHD). Luke lies on flat desert country that slopes slightly into the Salt River Valley. There are several small towns locally, but Luke is in a agricultural setting except for desert south and west.

Northwest-southeast oriented mountain ranges which are as close as 40 miles lie to the northeast and have tops over 7,000 feet within 50 miles. More important meteorologically are the White Tank Range (tops over 4,000 feet 10 miles west) and the Sierra Estrella (tops over 4,500 feet 15 miles south).

The large population of the Phoenix area (over 600,000) and some industry has created a significant pollution problem. Urban population growth tends to drift towards Luke and an ever increasing problem is expected. Although the prevailing winds at Luke are not from the southeast, pollution is still an occasional forecast problem under stagnating conditions. Rarely is the restriction ever worse than category D.

Field elevation is 1,101 feet, and the runway orientation is 03-21. The CHD Forecast Guide represents Luke terminal weather rather well.

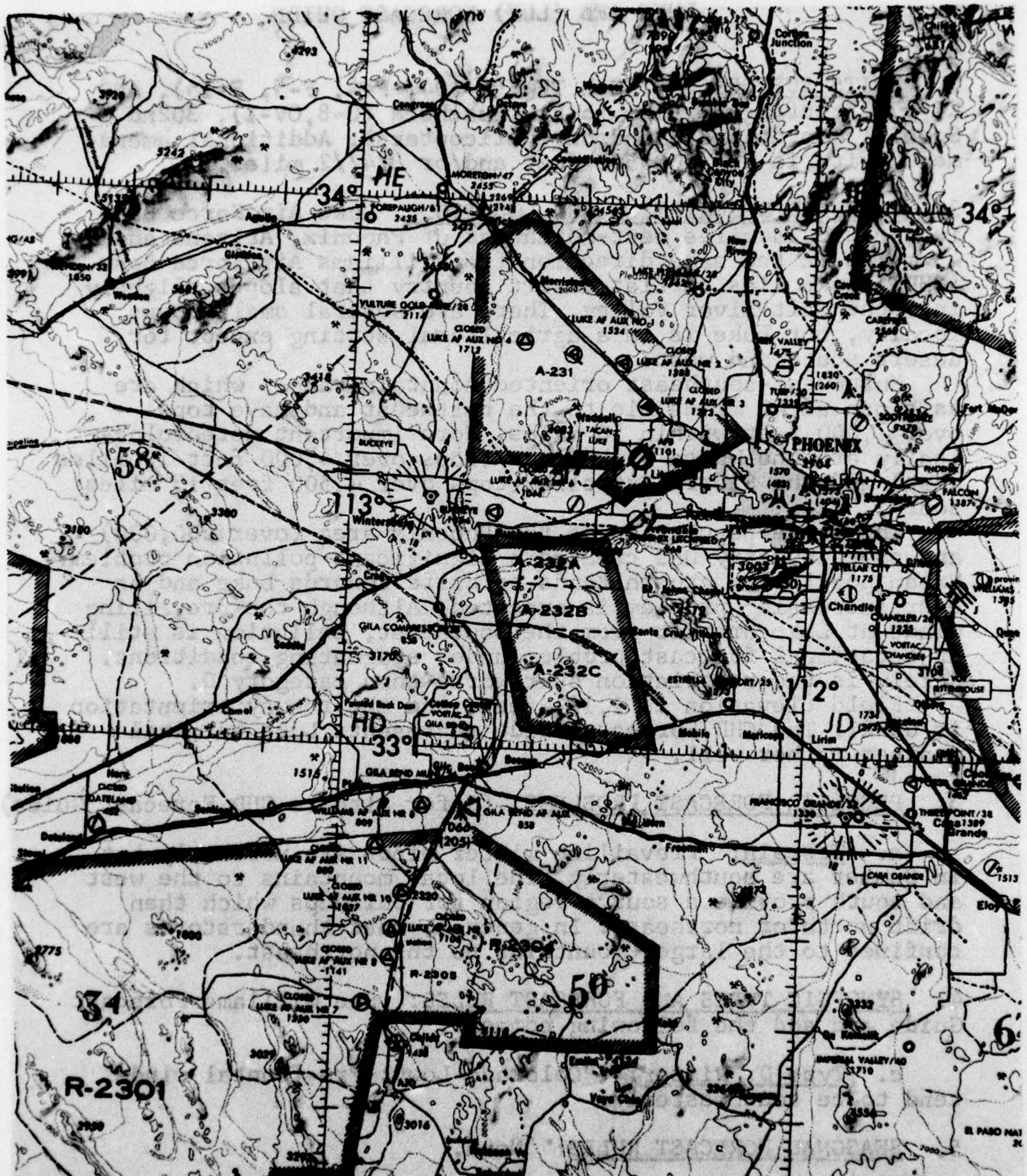
3. PECULIAR FORECAST PROBLEMS: (Refer also to CHD Forecast Guide)

a. Terrain: Prevailing winter winds are northerly but in Summer are southwesterly. The local mountains to the west and south provide a source region for buildups which then drift north or northeast. In general, most thunderstorms are confined to the larger mountains to the northeast.

4. SYNOPTIC TYPES AND FORECAST RULES: See Williams Forecast Guide and add the following comment.

c. Type D, Winter: "Colorado Low": Pre-frontal winds tend to be southwesterly.

5. SEASONAL FORECAST RULES: None.



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HE
HD
JD
HC
Chandler
Congress
Aguila
Wenden
Buckeye
Casa Grande
Eloy
Coolidge Junction

DAVIS-MONTHAN AFB (DMA) FORECAST GUIDE

1. UNITS SUPPORTED: 100th SRW Training and Operations (U-2), Training, (A-7), C-130, Drones, U-3, 5th FIG (F-106 from MIB).

2. PHYSICAL DESCRIPTION AND LOCATION: Davis-Monthan Air Force Base is located 5 miles southeast of downtown Tuscon. Residential areas adjoin the base on the southwest, northwest and northeast; undeveloped desert, comprising scrubby growth and dry washes, adjoin on the southeast. Terrain is rough with broad valleys separated by desert peaks and ranges. The Santa Catalina Mountains (Mt. Lemmon - 9,167 feet) are 15-20 miles north-northeast and the Rincon Mountains (Mica Mt. - 8,666 feet) are 15-20 miles east. The Santa Rita Mountains (Mt. Wrightson - 9, 453 feet) are 25-30 miles south. Ranges are oriented roughly north-south, and wide passes between them open into Mexico. The terrain slopes downward to the northwest toward Phoenix. The Santa Cruz River, 5 miles west of the base, is dry most of the year. There are no other local moisture sources.

Tuscon has a population of 400,000 but has limited industrial development. Primary pollution sources are automotive emissions and dust, but prevailing visibility remains good because southeasterly flow in the mean blows from the base toward the city.

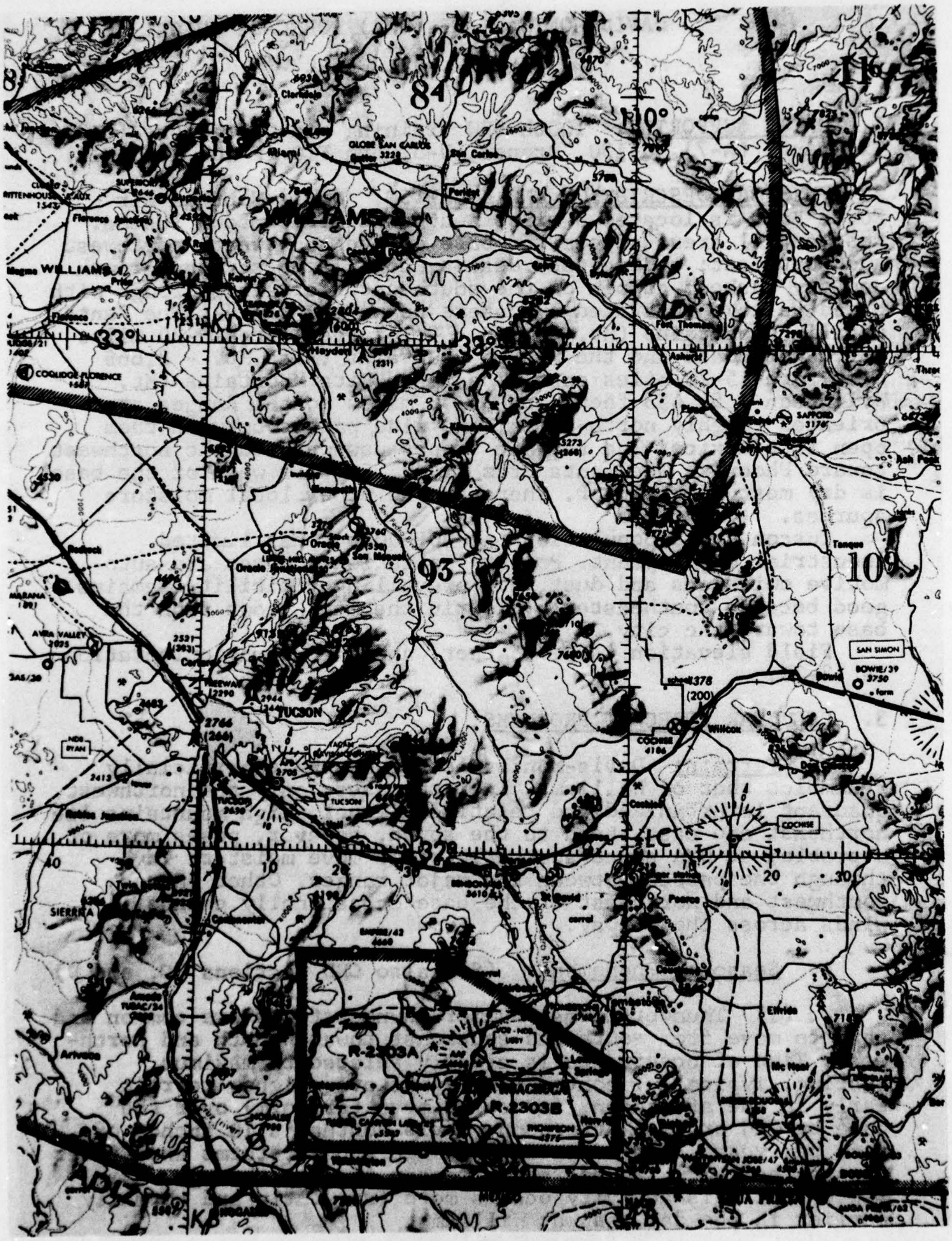
Field elevation is 2,705 feet, and the runway orientation is 12-30.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Davis-Monthan's topography superficially resembles that of Williams. In both cases, only the northwest quadrant is urbanized and relatively level. High mountains lie northeast and east. Land to the south, however, poses more of a problem at DMA since southerly winds move moisture in through the passes between the major ranges. Other passes southwest and northeast of the base occasionally channel winds across the runway.

b. Seasonal Phenomena: (See also CHD Sections 3C. and D)

(1) Thunderstorms: Summer thunderstorms are common and tend to move from south and southeast toward north and northwest. Time of occurrence is closely related to maximum heating. Typically, convection begins over higher terrain early in the afternoon, and cells move (or form) over the base by mid or late afternoon. Davis Monthan's 10 inches of rain per year is split evenly between thunderstorms and Winter frontal activity. Thunderstorm season is July through early September. This activity occurs more frequently and normally earlier in the day than at Williams.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TUCSON
R-2303A
R-2303B
SAN SIMON
BOWIE/39
COCHISE
SAFFORD
Willcox
WILLIAMS
Florence Junction
Oracle
MARANA
AVRA VALLEY
SIERRA VISTA
ADIZ

Storms that move over the base enter the valley through the Reddington Pass or between the Santa Rita and Tuscon Mountains (southeast). Storms forming over the Santa Catalina Mountains seldom affect the base. Movement of storms over the valley is erratic, and there appears to be no association particularly with 500 mb flow. Light easterly or southeasterly winds below the 300 mb level are considered most favorable for storm development; northerly to northeasterly winds - most unfavorable. Storms rarely occur after midnight, but when they do, stratus may form along the mountains and extend over the base, producing a ceiling below 2,000 feet with light continuous rain.

Rather important are the strong gusty winds and blowing dust which precede thunderstorm cells. Most peak gusts are in the 30-50 knot range with a record high gust of 67 knots. Blowing dust may produce category B visibility restrictions 30 minutes to an hour before the cell arrives. The reduced visibility and peak wind gust are of short duration but constitute the important forecast problems.

(2) Davis-Monthan lies in a valley with southeast-northwest orientation. Normal valley winds are southeasterly during mornings and northwesterly during afternoons. The valley floor, sloping downward toward the northwest, produces a southeasterly early morning drainage wind. As the valley floor warms during the day, flow through the valley reverses, and winds become northwesterly, 5 to 10 knots, from the surface to near 10,000 feet. During the evening, as the surface cools, winds become more variable. Near 0200L, as the drainage flow again becomes dominant, they shift to southeasterly.

(3) Dust Storms: Early in the thunderstorm season, when the ground is dry, downrush winds of 25 to 35 knots are necessary to lift dust from the desert. (Category B for 30 minutes up to D for an hour or more).

During the dry Winter months, an intensifying upper trough to the west of Tuscon can produce strong southwesterly winds and cause local dust storms. Although an intermittent condition, visibility may be restricted to category D for two hours or more.

Occasional dust storms, which result from superadiabatic surface heating between Tuscon and Phoenix move over the station from the northwest. Usually one or two hours before the base visibility is restricted, dust will be evident on the northwest horizon. Restrictions are the same as in the previous case.

Dust storms originating in the Gila River Valley, northwest through southwest of Phoenix, can also reduce visibility at DMA for periods up to two hours. Gusty northwest winds of 30 knots or more are necessary.

4. **SYNOPTIC TYPES AND FORECAST RULES:**

a. Type B, Winter: "Zonal Flow": Gusty winds from the south which shift to the northwest are the only concern. Some visibility restriction due to dust is possible.

b. Type C, Winter: "California Low": The location of the upper low is critical. If a front precedes the trough, widespread rain with category C nimbostratus should be forecast. In the absence of a front, heavy layered middle cloudiness is likely east of the closed low. Showers will cause lower conditions at times. Cloudiness will tend to linger in the mountains. Wind gusts out of the south to 25 knots are likely.

c. Type E_g, Winter: "Gulf Wave": Weather associated with an upper trough or cut-off low off the coast of southern California presents real forecasting problems at DMA. The base experiences strong cross-winds and several days of low ceilings and rainy weather until the system either dissipates or moves to the east.

d. Type B, Summer: "Low Amplitude Flow": Local thunderstorms have been discussed at length in Section 3. Activity usually occurs late in the day with dust restrictions to visibility likely.

5. **SEASONAL FORECAST RULES:**

A. Thunderstorms:

(1) D category ceilings occur with storms over the base.

(2) Gusts reach the base ½ to 1 hour before storm.

(3) Expect category B in dust initially.

B. Non-convective Peak Gusts: (Static synoptic situation) Approximate peak gusts can be determining by computing the gradient (mbs) between TUS and Deming (New Mexico) DMN and multiplying by three.

C. Fog: Forecast *if*:

(1) Temperature - dewpoint spread $\leqq 4^{\circ}$ F.
(2) Rain the day before.
(3) Northwesterly (upslope) winds from 2-6 knots. Winds greater than 6 knots will generally cause B category stratus with no visibility restriction.

(4) Fog starts forming at 0100L and reduces visibility to its lowest level at 0430-0600L.

(5) Once the fog starts breaking, it generally breaks up completely within 2 hours.

HOLLOMAN AFB (HMN) FORECAST GUIDE

1. UNITS SUPPORTED: 49th TFW (F-4, T-38), Radar and Target Scattering Test Facilities.

2. PHYSICAL DESCRIPTION AND LOCATION: Holloman Air Force Base lies in the Tularosa Basin nine miles south of Alamogordo, New Mexico and 75 miles north-northwest of El Paso. The Tularosa Basin is oriented north-south and is bounded on the west by the 7,500 foot San Andreas Mountains (26 miles) and on the east by the 9,000 foot Sacramento Mountains (11 miles). The valley floor is about 4,000 feet high and is part desert scrub and part sand. A small range of hills, the Organ Mountains (5,000 feet) partly block the valley 25 miles south of Holloman.

3. PECULIAR FORECAST PROBLEMS:

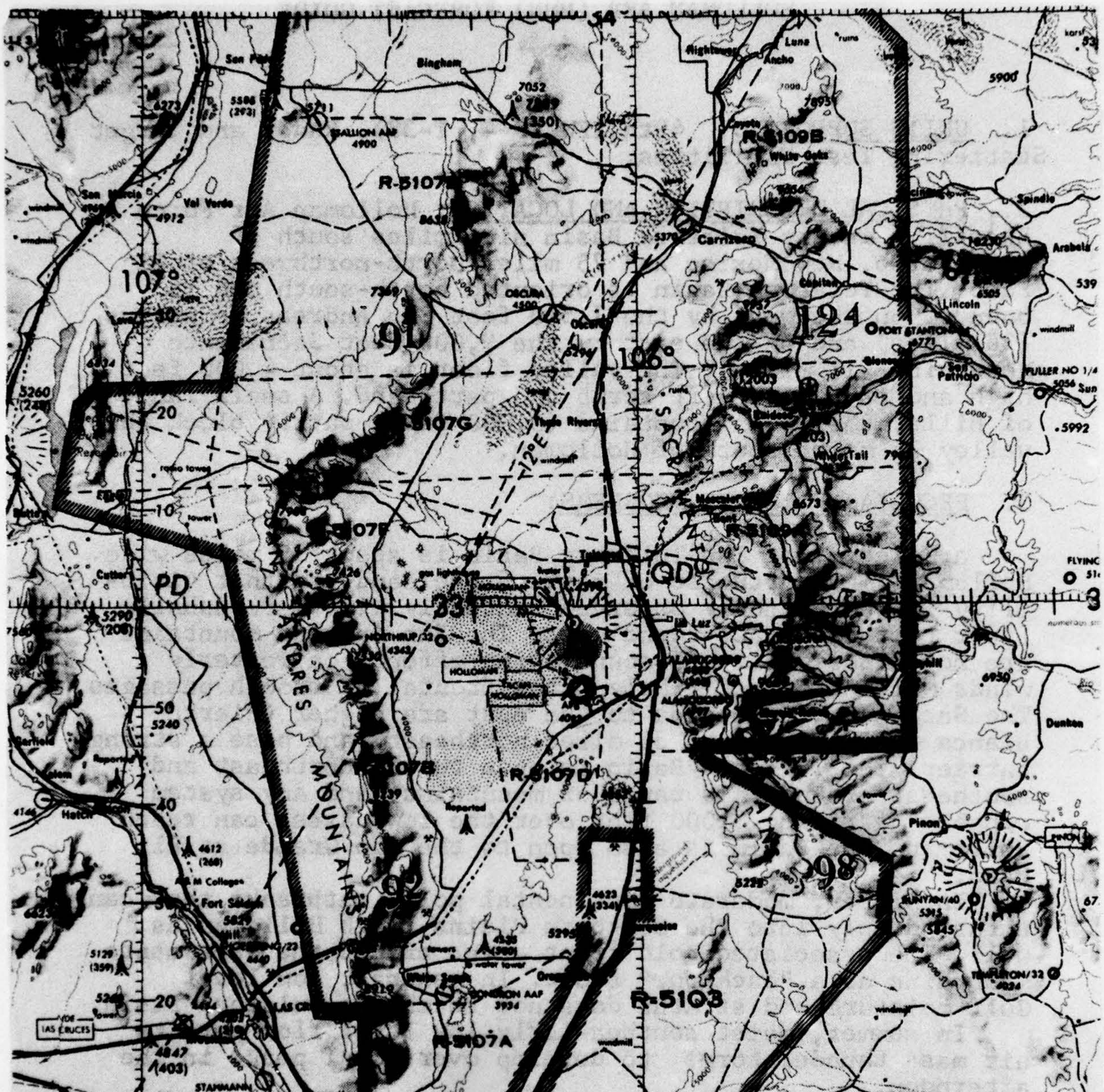
a. Terrain: The Tularosa Basin is about 35 miles wide. Holloman lies northeast of most of the sand, so that visibility in the commonly observed southerly winds are usually lower to the southwest and west. The San Andreas Mountains are noted for their dry downsloping effects on westerly winds which are most likely after frontal or trough passages. The Sacramento Mountains to the east are higher (Sierra Blanca is 12,003 feet; 34 miles northeast) and pose a strong barrier. The Tularosa Basin is open to the northeast and southeast around this range of mountains, and any system capable of rising 3,000 feet over the low passes can reach Holloman. The Basin is also open to the Rio Grande at El Paso.

In Winter, moderate continental polar outbreaks that can thrust deeply into the Southern Plains reach Holloman as well. The associated cold front moves around the Sacramento Mountains as a "backdoor" front. In general, low level Gulf moisture and stratus does not reach the Tularosa Basin.

In summer, moist southeasterly low level flow permits air mass thunderstorms to develop over local peaks in the afternoon.

b. Transient Controls: Cold frontal passages including fronts aloft periodically occur at Holloman. Most are accompanied by middle clouds, rain or snow showers and strong winds at the surface, capable of seriously reducing visibility in blowing dust. In general, most fronts precede mP air from the west and northwest. General clearing occurs after passage of the 700 mb trough.

Summers will be dry when hot continental air from Mexico dominates the area or when the Bermuda Ridge is not in place.



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R-5109B
Carrizozo
Lincoln
R-5107G
R-5107F
R-5107B
R-5107D
R-5107A
R-5103
HOLLOMAN
MOUNTAINS
LAS CRUCES
NEW MEXICO
TEXAS
CIUDAD JUAREZ
EL PASO
SALT FLAT
Dell City
Dunken
pumping station
abandoned beacon

Holloman receives most of its annual 7 inches of precipitation in summer air mass thunderstorms or showers. Surface winds throughout the year tend to be southerly.

4. SYNOPTIC TYPES AND FORECAST RULES:

a. Type B, Winter: "Zonal Flow": Fronts that pass through the area are dry. Winds turn northerly as a portion of the Great Basin High moves out of the Rockies into the Plains. Dust may be picked up

b. Type C, Winter: "California Low": The strong upper level low is always west of Holloman as long as the pattern exists. Forecast heavy cirrus and occasional middle cloud ceilings. Some cumulus will develop with heavy thunderstorm activity over the mountains. If a front is associated with this pattern or a series of fronts for that matter, treat each with the above weather plus periods of low D category in showers.

c. Type D, Winter: "Colorado Low": Migratory lows in this pattern begin intensifying in Utah and Colorado. The air mass may change twice at Holloman; first to mP then to cP.

(1) Pre-frontal winds develop over six hours before passage. Winds are southerly, may gust to 40 knots in the daytime and reduce visibility to C or D category in dust.

d. Type E, Winter: "Texas Low": The Texas Low is a more southerly version of the Colorado Low and may cause complications if it decides to develop in eastern New Mexico. Weather resembles that of the Type D cold front, but prolonged poor conditions may be expected if the low develops slowly. Extensive C category nimbostratus and widespread rain can occur. Stratus occurs with cP front.

e. Type E_s, Winter: "Gulf Wave": The Gulf Wave on the surface is obviously too far to the southeast to be a problem, but the periodic upper troughs moving out of the southwest U.S. cause conditions similar to the Type D cold front.

f. Type B, Summer: "Low Amplitude Flow": This is the normal Summer pattern. Southeast flow aloft brings in sufficient moisture to increase thunderstorm activity. Intermittent category D ceilings may occur with thunderstorms that move right over the base. Gusty winds raise dust and cause visibility restrictions.

5. SEASONAL FORECAST RULES:

a. WINTER: Polar front on lee side of Rockies and strong high in southern Oklahoma or northern Texas (possibly being overrun). Do not advect stratus from the northeast or south-

east, only from the south when ELP has at least 8 knots from 170-190°.

b. SPRING: The predominant directions of gusty winds are 210-310°.

REGION 11

SOUTHERN PLAINS FORECAST GUIDES

WEBB AFB (BGS) FORECAST GUIDE

1. UNITS SUPPORTED: 78th Flying Training Wing (T-37, T-38)

2. PHYSICAL DESCRIPTION AND LOCATION: Webb Air Force Base is located in west central Texas about mid-way between Dallas and El Paso. The town of Big Spring is one mile northeast. Webb is in near desert country which consists of mostly scrub with some cultivated areas. The base lies 100 feet above the town, and local hills rise up to 500 feet more. The land gently rises nearly 700 feet in 100 miles southwest through northwest toward the foothills of the Rockies 200 miles west-northwest and also to the mountains in the Big Bend area 150 miles southwest. Field elevation is 2561 feet, and the runways are oriented 17-35.

3. PECULIAR FORECAST PROBLEMS:

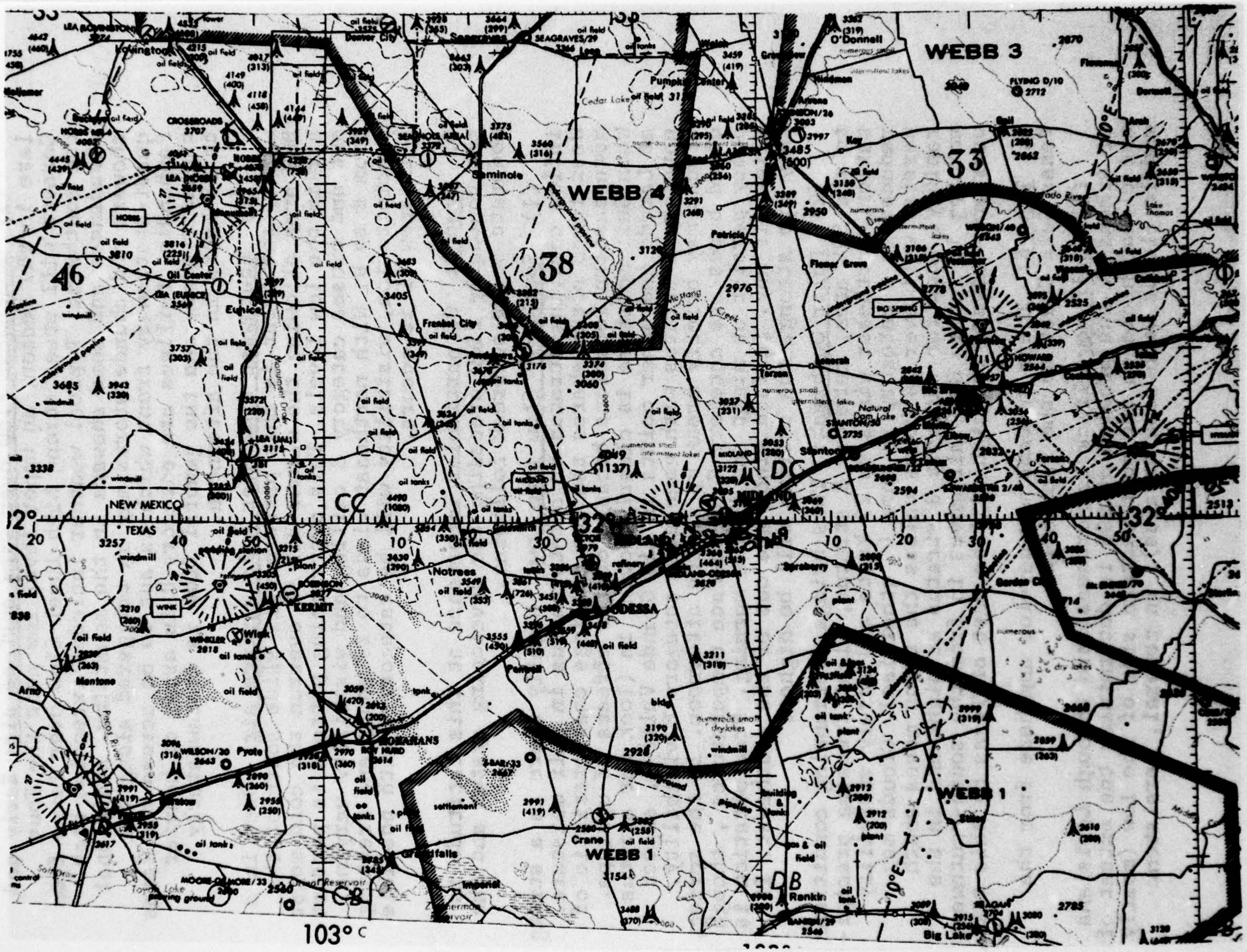
a. Terrain: The local terrain is slightly rolling but in the macroscale, the land is fairly flat. There are bluffs and mesas nearby. Scenic Mountain is a mile southeast and 500 feet above the base. Big Spring itself is in a low valley below the base. When fog collects there in the winter, Webb is usually unaffected. There is a refinery 10 miles east of the base, but neither it nor any other industry restricts visibility. Westerly winds easily stir up dust during the dry spring and fall seasons especially when associated with fast-moving fronts.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Ridging over the western U.S. discourages fronts from moving into the Southern Plains. Prevailing conditions are fair and dry.

b. Type B: This differs only from Type A in that the Great Basin High tends to be active, and portions of it follow weak cold fronts into the Plains. Category D visibility in blowing dust with wind gusts over 30 knots for 3 hours is about the worst conditions that will occur with this type front.

c. Type C: There are two likely variations of this pattern. Keep in mind that the surface front is almost always stationary north of BGS. As a result, the second pattern is relatively rare.


WEBB 3
WEBB 4
WEBB 1
WEBB 1
46
38
33
NEW MEXICO
TEXAS
103°
32°
Seminole
Eunice
Kermit
Odessa
Midland
Crane
Rankin
Big Lake
Pecos River
O'Donnell
Notrees
Stanton
Big Spring
Crossroads
Monahans
Pyote
Wink
Grandfalls
Imperial
Spraberry
Lovington
Seagraves
Lamesa
Patricia
Flower Grove
Gail
Lake Thomas
oil field
windmill
numerous small intermittent lakes
DC
CC
DB
10°E

(1) Southwest Flow over warm surface air: Early and late in the season, an upper level low near the Four Corners will steer strong high level flow over Texas from the southwest. Typical weather includes extensive high cloudiness and some showers in the mountains. Additional showers and thunderstorms may be triggered along the quasi-stationary front which is apt to be across the Texas Panhandle. Ceilings are category D in areas of heavier thunderstorms, and the general flow is southwesterly to 25 knots in the afternoon.

(2) Southwest flow over cold surface air: Once in a while, the front is this pattern will slide south of the BGS area allowing the warmer air to overrun the cold moist air in the low levels. This overrunning pattern is persistent and causes category B ceiling and visibility varying from B to D. With northeast winds to 25 knots and freezing precipitation, visibility will be category C with possible B in snow if it occurs.

d. Type D: Of particular importance at this latitude is the southerly flow preceding the developing system and the moderate polar outbreak following.

(1) Southerly flow into Low: Usually there is a strong inflow carrying stratus or stratocumulus in gulf moisture. West Texas often shares the low ceilings characteristic of more eastern locations because of the effects of upslope. When Gulf moisture is clearly moving in (look for stratus at Laredo and other points in Rio Grande Valley), expect category B stratus with generally category E visibility. Clouds may briefly break up in the afternoon. In the spring, cloud bases are category C as surface temperatures , though B may persist at night and in the morning. Precipitation is slight if any. Surface winds are out of the southeast. If they are strong, the ceiling will be higher.

(2) Polar Outbreak: This brings overrunning conditions to the BGS area; category B stratus, light freezing precipitation, northeast winds to 25 knots and rarely visibility reduced to B category in snow (C otherwise). Clouds may persist well over 24 hours unless the front moves south rapidly. Look for category B stratus at night and in the morning if return Gulf air moves in from the south-southwest over snow cover. The high will be east of Texas by this time.

e. Type E: These systems may develop anywhere from the Texas Gulf Coast to the Panhandle.

(1) Gulf Low: Track is northeastward through Louisiana or Arkansas. The problem at BGS is determining the extent of the cloud shield on the northwestern side of the low (mostly middle clouds with some stratus). In general, persistent

category D ceilings occur until the low moves out of the Gulf. Then look for stratus associated with the invasion of polar air (possible also from backwash around deepening lows). It occurs mostly at night and in the morning and should not last more than two consecutive days. Precipitation is light, but the intensity of the system does depend upon the area of formation.

(2) Panhandle Lows: These resemble Type D Colorado Lows, but there are distinct differences in the observed weather. The southerly flow usually does not last long enough to bring stratus into west Texas. Late in the season, thunderstorms may develop along instability lines in the warm sector. The lows develop north of BGS and DYS, so that warm front weather is unlikely. The cold front precedes a major polar outbreak. Surface winds are gusty in the afternoon while the low is in the Panhandle.

SUMMER

a. Type B: Southeast flow around the Bermuda High aids the development of afternoon air mass thunderstorms (quite isolated). Of particular interest is the "dry line" or Marfa Front which separates dry air from relatively moist air. Afternoon activity may develop along the line and drift eastward with it. Activity on the line is particularly heavy when supported aloft by a sharp trough or divergence in the flow.

b. Type E: The major feature is the absence of Bermuda Ridge influence on Texas, so this pattern is more typical of the fall season. If weak cold fronts drift into the area from the north, expect thunderstorms on and south of the front particularly in the afternoon and evening.

5. SEASONAL FORECAST RULES:

ALL SEASONS

a. Moist Gulf flow comes in southeast flow bringing category B stratus in winter. Northwest flow is downslope and dry.

b. Visibility restrictions in dust are category D with 25 knots and category C with winds over 30 knots.

SUMMER

a. Air mass thunderstorms require deep middle level moisture profiles and instability. Activity is isolated and favors no particular area.

DYESS AFB (DYS) FORECAST GUIDE

1. UNITS SUPPORTED: 96th Bomb Wg (B-52, KC-135), 463rd Tactical Airlift Wing (MAC).

2. PHYSICAL DESCRIPTION AND LOCATION: Dyess Air Force Base is 7 miles west of Abilene in west central Texas. The terrain rises to the southwest where low hills rise to 2,400 feet about 15 miles away. The macroscale rise in the land, however, is towards the west-northwest. The lower elevations exist to the northeast. Field elevation is 1,789 feet, and the runways are oriented 16-34.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The local terrain is gently rolling, but there are scattered clusters of hills which reach to 700 feet above the level of the base. The hills southeast and southwest of Dyess tend to break up the stratus when the flow is from the southeast. Even extensive stratus invasions may affect Dyess less and allow scattering in the afternoon. If clouds are generally patchy late in the season, they certainly will be scattered at Dyess. The hills have no effect on post-frontal stratus in northerly flow or on the formation of ground fog. Westerly winds may raise dust during the day in the spring and fall. Minimum visibility is generally category D with an intermittent decrease to category C possible. There are no local pollution sources of importance.

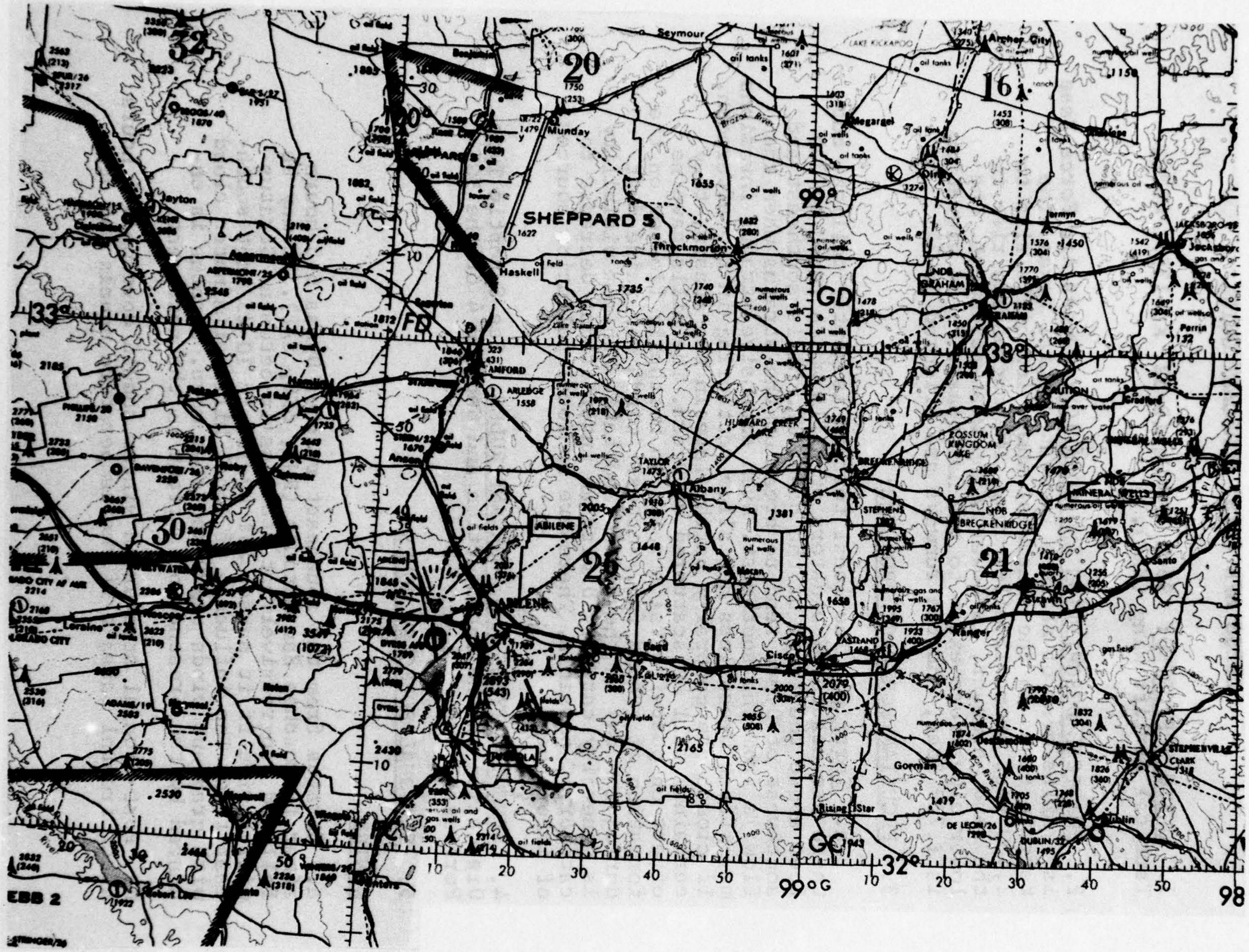
4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the BGS Forecast Guide.

5. SEASONAL FORECAST RULES:

WINTER

a. Stratus from the southeast reaches Dyess 6-8 hours after it reaches San Antonio (RND, SKF, SAT). It may be followed progressively at stations in between. Stratus will arrive if it passes SJT by 10Z in 10-25 knot southeast flow. The influence of local hills eliminates cloud with gradient winds of 30 knots or more. Stratus is enhanced by the presence of a front to the northwest.

b. Post-frontal stratus in winter should develop 4-6 hours after frontal passage if the temperature equals the dew-


SHEPPARD 5
Seymour
Munday
Haskell
Throckmorton
Megargel
Olney
Archer City
Jacksboro
Graham
Albany
Abilene
Cisco
Eastland
Ranger
Gorman
Rising Star
Stephenville
Dublin
Anson
Breckenridge
Possum Kingdom Lake
Hubbard Creek Lake
Lake Kickapoo
EBB 2
99°
33°
32°
98

point reported before frontal passage. It must form within 8 hours if it is to form at all (category B). More intense polar outbreaks bring stratus and freezing precipitation with the front. Category B conditions persist beyond 24 hours.

c. Post-frontal stratus in winter is persistent when the upper air trough is west of Dyess and is out of phase with the front. Clearing is certain with trough passage. Any other trough condition means brief stratus (under 6 hours) or none at all.

d. Developing Panhandle Lows generate southerly or southwesterly afternoon winds to 25 knots. Gradient winds: expect 35 knot gusts or more during 16-22Z when the 12Z sea level pressure difference between Lubbock (LBB) and Waco (ACT) is 10 mbs or more, and <u>no</u> ceilings are forecast. The peak gust is 3.6 X (LBB-ACT).

<u>SPRING-SUMMER</u>

a. The dew point Dry line in summer is usually west of Dyess, but it passes through in the afternoon often associated with thunderstorms. It usually reforms to the west at night.

b. Springtime squall-lines bringing heavy rain will likely cause sunrise radiation fog the next day. For this phenomenon to occur, skies should be clear, and surface winds calm.

c. Dust bearing winds are west through north. The visibility may be briefly category C with fast-moving fronts but are otherwise category D for a few hours.

REESE AFB (REE) FORECAST GUIDE

1. UNITS SUPPORTED: 64th Flying Training Wing (T-38, T-37). Additional amendment criteria are 300 feet and/or 1 mile.

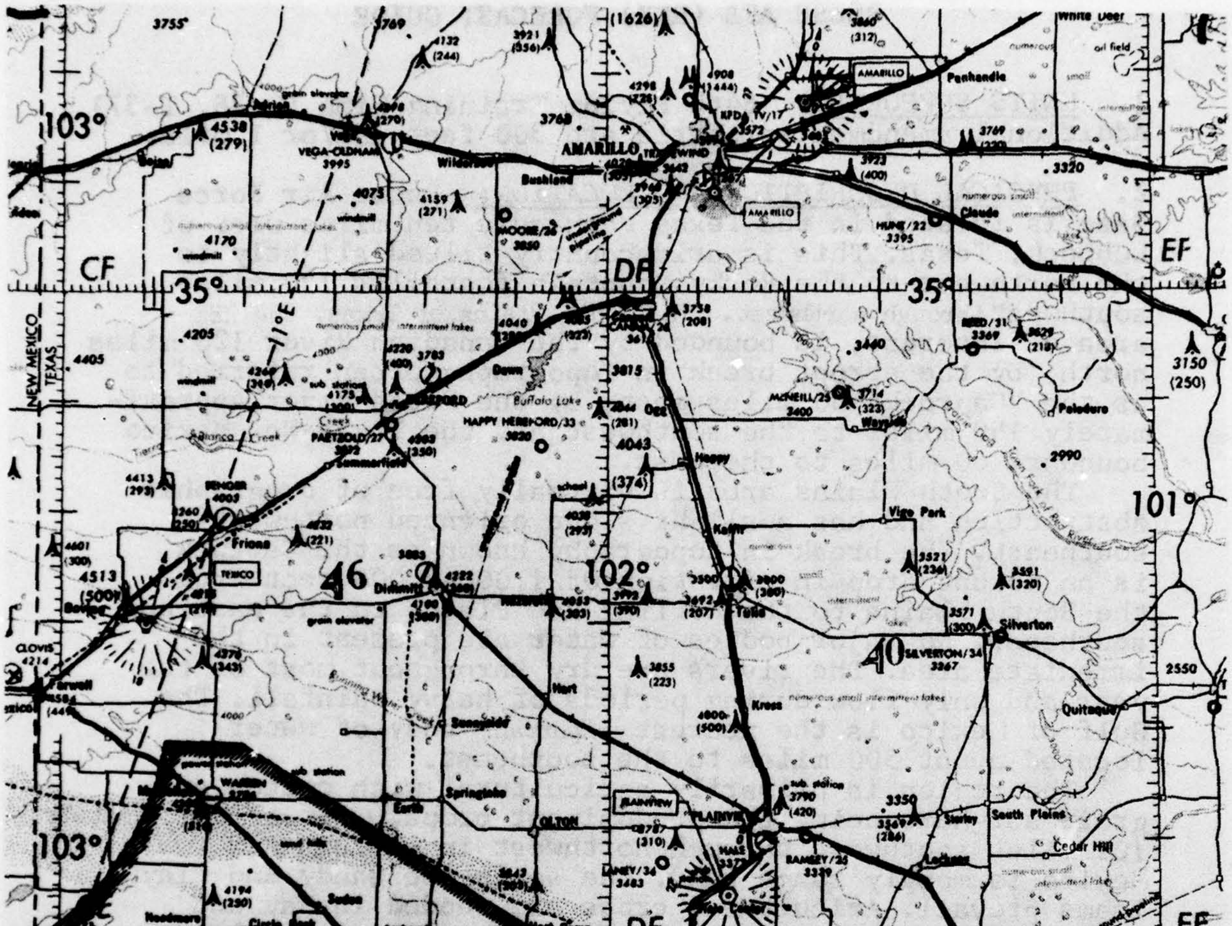
2. PHYSICAL DESCRIPTION AND LOCATION: Reese Air Force Base is located in the Texas Panhandle ten miles west of Lubbock, Texas. This is arid country tilted slightly to the northwest to the Rocky Mountain foothills 150 miles southwest through northwest. The South Plains of Texas, the REE area of interest, is bounded by the Canadian River 120 miles north, by the abrupt break in Topography often referred to as the "Caprock" 50 miles east, by the Pecos River approximately 150 miles to the southwest and the Texas-New Mexico boundary 60 miles to the west.

The South Plains area is virtually free of orographic obstruction and has a slight slope oriented northwest-southeast. The break in topography known as the Caprock is an abrupt drop in elevation of 1,000-2,000 feet from the South Plains to the Rolling Red Plains to the east and southeast. No major bodies of water are present in the immediate area. The rivers are dry throughout most of the year and only flow during periods of heavy rainfall. The Gulf of Mexico is the nearest important body of water located about 500 miles to the southeast.

The region is primarily agricultural with cotton and grain sorghums being the predominant crops. The are approximately 100 miles southwest through northwest in eastern New Mexico is mostly range land. The soils are sandy and clay loams prevail. Aricultural crops are seeded in May and harvested by January. Between January and May, the land is void of vegetation. During periods of extreme drought, there are little obstructions to blowing dust. This blowing dust and sand constitute the principle form of air pollution. Some smoke particles and combustion by-products are introduced during the fall cotton ginning season from nearby gins. No other major industrial sources exist.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The wind flow is predominantly from the south and southwest. During periods when flow is southeasterly off the Gulf, the relative humidity increases substantially. Westerly winds produce downslope flow and when persisting over a period of time of approximately six hours or greater produce a "Chinook" effect which causes abnormal increases in temperature during daylight hours. The air is largely modified as it comes over the mountains in central New Mexico. The mountains in central New Mexico and the Guadaloupe Mountains in west Texas produce a block


AMARILLO
Panhandle
White Deer
Vega
VEGA-OLDHAM
Wildorado
Bushland
Claude
CF
DF
EF
35°
103°
102°
101°
NEW MEXICO
TEXAS
Buffalo Lake
HAPPY HEREFORD/33
Canyon
Umbarger
Dawn
Happy
Wayside
Palo Duro
Friona
Bovina
TEXICO
CLOVIS
Farwell
Dimmitt
Tulia
Kress
Vigo Park
Silverton
SILVERTON/34
Quitaque
Hart
Springlake
Earth
Olton
PLAINVIEW
Sudan
Amherst
Muleshoe
Circle Back
Needmore
Hart Camp
DE
EE
Lockney
South Plains
Cedar Hill
Floydada
Dougherty
Lakeview
Abernathy
Petersburg
REESE 1
LITTLEFIELD
Anton
Whitharral
COCHRAN/26
Morton
LUBBOCK
Idalou
Lorenzo
Ralls
Crosbyton
Levelland
Slaton
Wilson
Southland
Tahoka
Post
POST GARZA
Graham
Grassland
Justiceburg
Brownfield
Plains
REESE 2
REESE 4
REESE 5
ED
Whiteface
Lehman
Ropesville
New Home
Meadow
Wellman
46
40
34
37

against moisture sources to the southwest or west of Reese. Therefore, southwesterly to northwesterly lower atmosphere winds over the REE area cause the lower atmosphere to dry out. Preventing formation of stratus or cumulus clouds results. Northeasterly through south-southwesterly winds cause upslope flow, and when moisture is available upstream, low cloud ceilings are eventually formed as moist air is lifted over the Caprock.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the BGS Forecast Guide. Note also the following:

a. Dust storms with fast moving fronts in the spring may lower visibility to category B initially, but D is more general lasting for several hours.

b. Stratus is less persistent and less likely to affect Reese with southeasterly inflow in the winter than stations further east. This is not true in the spring.

c. The dry line tends to be east of Reese in the summer, so the base is in fair weather most of the time.

5. SEASONAL FORECAST RULES:

ALL YEAR

a. East-west cold fronts may or may not stall depending on the following conditions. An APP rise of 2.5 mbs or more at Amarillo (AMA) for three hours after frontal passage indicates no stalling. Otherwise , the front should stall. The rate of movement for a front before reaching Amarillo does not imply future movement. When the push is weak from the north, fronts typically decelerate in the daytime and accelerate at night.

WINTER-SPRING

a. When a low pressure area is centered over the Texas or Oklahoma Panhandles, western Kansas, eastern Colorado or a north-south oriented trough line lies west of REE, gusty winds should be forecast.

b. High nighttime pressure falls at ABQ and ELP relate to strong surface winds over the west Texas area the next day.

c. Wind direction at REE will be plus or minus twenty degrees of the 850 mb isotherm orientation.

d. Gusty winds will begin when the surface temperature reaches the dry adiabat that crosses the 5,000 foot MSL Amarillo sounding point.

e. If the winds aloft are light and variable at 8,000 feet to 10,000 feet MSL and the low level winds (5,000 to 8,000 feet MSL) are strong (25-30 knots), then the winds will decrease on the surface when the temperature reaches the dry adiabat that crosses the Amarillo sounding at 8,000 feet.

f. With east-west oriented fronts, gusty winds will prevail until about two hours prior to frontal passage. At this time, a lull can be expected.

g. Again with east-west fronts, maximum gusts at frontal passage will be the 5,000 foot wind speed six hours prior to frontal passage plus 15 knots. If a "fine-line" is evident on FPS-77 radar, forecast 45 knots.

h. East-west fronts: Stratus usually forms or is advected in 2-4 hours after frontal passage. The time of occurrence at Amarillo in relation to frontal passage is an excellent guide. Note: The wind should be north through northeast for stratus.

i. Stratus generally dissipates or is scattered 2-4 hours after winds have shifted to the south of east.

j. Upslope stratus forms or is advected in normally between 0600-0800L when the wind direction is south-southeast through east-southeast provided San Angelo had stratus the previous morning.

k. Stratus normally dissipates or scatters by 0900-1000L with clear skies above; 1000-1200L when a high ceiling exists above and 1200-1400 when a middle cloud ceiling exists. (Two hours after middle clouds move out). This applies to upslope stratus only.

SPRING-SUMMER (Thunderstorms will occur when the following conditions exist)

a. Vorticity isopleths intersect the 500 mb contour field at an angle of 45-90 degrees.

b. SSE to SSW winds to 6,000 feet or higher.

c. A dewpoint at REE greater than 45 degrees F. (Severe if greater than 55 degrees).

d. When the dry line forms during the late morning between REE and CVS.

e. If the winds at GDP are southerly and less than 15 knots with a dewpoint of greater than 40°F and there is a rapid

shift in winds to the southwest with speeds greater than 15 knots plus a drop in dewpoint to less than 35°F, look for thunderstorm development southwest of REE.

f. If the dry line moves from west of Reese to east of Reese during the late morning or afternoon hours (not associated with frontal activity), it will return to a location west of Reese that night. If there is cold air advection aloft, thunderstorms will form at the time of its return. Severity of the thunderstorm activity will depend on the surface temperature at the time of the return of the dewpoint line.

FALL-WINTER (Forecast ceilings and restriction to visibility when:)

a. Northeast winds from the surface to 5,000 feet indicate the possibility of upslope stratus and/or fog within 12 hours after onset of the winds. If winds continue throughout the night, any stratus the following morning will be less than 1,000 feet. If the northeast flow begins in the early morning or afternoon, ceilings will be 1200-2000 feet at onset.

b. If the 500 mb trough is forecast to orient itself west of Reese in a southwest-northeast direction with winds coming from Baja, look for the onset of middle cloud ceilings within 24-36 hours after initial orientation.

c. A temperature of -25°C at the 500 mb level over Medford, Ore. for a 24 hour period will mean the formation of a closed low south of San Diego, California.

d. When a cut-off low moves out of the Baja area with the forecast trajectory south of Reese, low ceilings, visibility and precipitation can be expected at Reese within 24-36 hours.

CANNON AFB (CVS) FORECAST GUIDE

1. UNITS SUPPORTED: 27th TFW (F-111).

2. PHYSICAL DESCRIPTION AND LOCATION: Cannon Air Force Base is located a few miles west of Clovis, New Mexico in the extreme east central portion of the state. Although the base lies on a broad ridge, there are no mountains within 100 miles. The country is arid grassland only partially cultivated. Pollution is not a factor, but dust can be owing to the numerous local sand hills. Field elevation is 4,295 feet, and the primary instrument runway is 035-215 with an alternate 125-305.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Upslope is the major terrain feature at Cannon. Land slopes upward in all directions except west and northwest. In those directions, there is downslope.

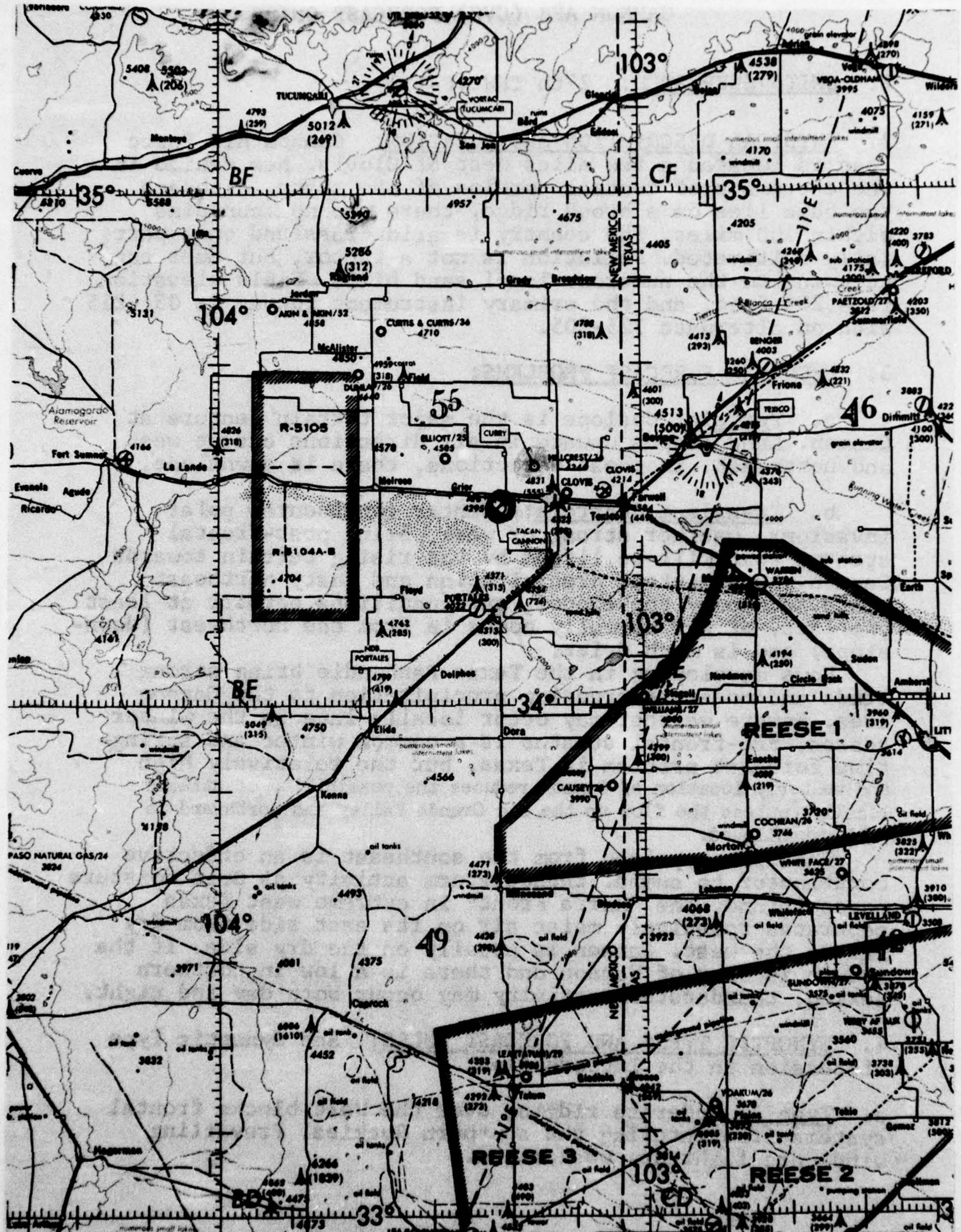
b. Transient Controls: Winter continental polar invasions, whether strong or weak, bring post-frontal stratus that will be lifted by the rising terrain towards Cannon. Intermittent precipitation and gusty northeast winds accompany the clouds, and conditions persist at least two days. mP air normally comes in from the northwest (downslope) and is much drier.

Lows developing in the Texas Panhandle bring strong winds and moderate freezing precipitation to the Cannon area. Severe weather may occur locally late in the winter season. Pre-frontal stratus is a common winter and springtime forecast problem in Texas, but the relatively high and westerly location of Cannon reduces the possibility of stratus locally (unless the flow up the Rio Grande Valley and northward is well established.

This same upslope from the southeast is an effective contributor to summer thunderstorm activity as Gulf moisture moves inland. The "Marfa Front" in extreme west Texas separates relatively moist air on its east side from dry air to the west. Cannon is usually on the dry side. If the trough is west of Cannon and there is a low in northern Mexico, thunderstorm activity may occur both day and night.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Moderate ridging over the West blocks frontal systems from entering the southern Rockies. Prevailing winds are light dry westerlies.


TUCUMCARI
103°
35°
BF
CF
104°
R-5105
R-5104A-B
55
CURRY
CLOVIS
CANNON
PORTALES
TEXICO
Friona
46
Fort Sumner
La Lande
Alamogordo Reservoir
Melrose
Floyd
Delphos
Elida
Kenna
Dora
34°
BE
NEW MEXICO
TEXAS
REESE 1
Morton
LEVELLAND
Sundown
49
REESE 3
REESE 2
Hagerman
33°

b. Type B: This variation of the previous type includes occasional trailing cold fronts in the Plains preceding portions of the Great Basin High. The northwesterly and northerly flow that follows is usually dry and involves only a change of wind direction.

c. Type C: Strong flow aloft out of the southwest U.S. brings considerable high cloudiness for days. For details, see the BGS Forecast Guide. The weather will depend upon the location of the front through the Southern Plains.

d. Type D: Migratory lows move into Colorado or become active in the lee-side in northern New Mexico. Track is out into the Central Plains with a following polar outbreak. The mP front will be rather dry when it reaches Cannon. Gusty southerly pre-frontal winds may significantly affect visibility. As the front or trough approaches, some D category cloud is likely with possible showers. The surface front becomes more distinct as it moves into Texas. A moderate outbreak will reach Cannon. Northwest winds bring some stratus and intermittent light snow showers and visibility is typically category B in precipitation. Visibility will improve rapidly when precipitation stops.

e. Type E: This system develops in the Texas Panhandle or to the southeast. Once in a while, a closed off system will develop on the surface in southern New Mexico and move out into the Panhandle. If this happens, forecast overcast category B ceilings until the low moves out. A strong polar outbreak follows. If the low develops further east as is usually the case, CVS will only be peripherally affected with D category ceilings and a few snow showers. Some category C stratus will form when the cP front passes through the area.

SUMMER

a. Type B: This is a mid-summer pattern characterized by air mass thunderstorms. These are usually isolated and favor the area along and east of the Marfa Front. Thunderstorms move in from the south or southeast in the afternoon and evening.

b. Type E: This is more of a late Spring and late Fall feature. Occasionally a winter-type system will move through the CVS area. Thunderstorm activity will form along and ahead of the front.

5. <u>**SEASONAL FORECAST RULES**</u>**:**

a. Ceilings associated with thunderstorms are 3,000 feet or greater.

b. Visibility with thunderstorms is 3 miles or greater.

TINKER AFB (TIK) FORECAST GUIDE

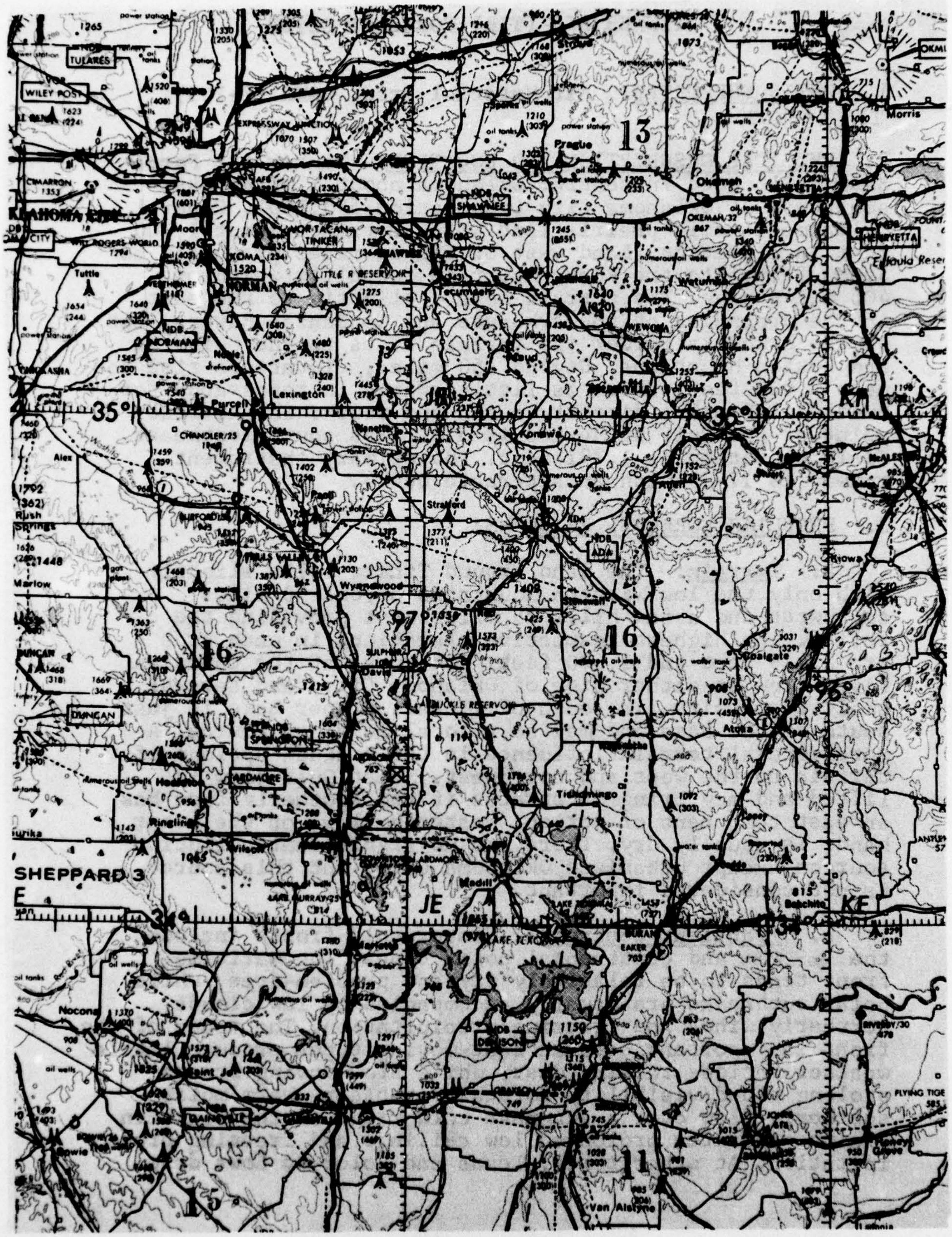
1. UNITS SUPPORTED: Air Material Area, OANG (F-105). TFG (AFRES).

2. PHYSICAL DESCRIPTION AND LOCATION: Tinker Air Force Base is located in central Oklahoma about 5 miles east-southeast of Oklahoma City (population 350,000). Central Oklahoma is arid prairie land which averages about 1,000 feet in elevation. Land west of Tinker rises gradually to 5,000 feet into the Rocky Mountain foothills which are 400 miles away. The terrain lowers slightly to the east in the drainages of the Arkansas and Candanian Rivers, but on the Arkansas border the terrain rises to the Ouichita and Boston Mountains. Beyond 150 miles, elevations rise to near 3,000 feet. There is little change in topography for hundreds of miles directly north and south. The nearest point of the Gulf of Mexico is 375 miles south-southeast. Field elevation is 1,291 feet. The primary instrument runway is 17-35 with an alternate 06-24.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The land around Tinker rolls slightly with only the low Wichita Mountains beyond 50 miles southwest and a few hills 25 miles west providing the relief. The highest respective elevations in each area are 2,479 feet and 1,620 feet. Two forks of the Canadian River flow on either side of Oklahoma City, and several small reservoirs lie south of Tinker. Draper Lake is just south of the base and may be a local moisture source. A more general terrain influence is the gradual upslope of terrain to the west and northwest. Moist Gulf flow is lifted and may bring in stratus if the southerly flow has an east component of motion. Westerly flow, on the other hand, is usually dry. There are no significant pollution sources except urbanized Oklahoma City, but this source is not considered important.

b. Transient Controls: Winter cold fronts include the maritime and continental polar types. The maritime front tends to be relatively dry and problem-free, while polar outbreaks are usually accompanied by low clouds, northerly winds and freezing precipitation. The speed of the front is important because fast-moving types produce little weather besides raising dust, while slow-moving fronts prolong cloud/visibility forecast problems. Warm moist southerly flow over a stagnant cold ridge in the Southern Plains generates prolonged low ceilings and freezing precipitation. At other times, Texas and Colorado Lows draw



TULARES
WILEY POST
EXPRESSWAY JUNCTION
CIMARRON
NORMAN
Lexington
Purcell
35°
Prague
13
SHAWNEE
Okemah
HENRYETTA
Morris
Tecumseh
Wetumka
Wewoka
Konawa
Stratford
Ada
Wynnewood
Marlow
DUNCAN
16
Davis
ARBUCKLE RESERVOIR
Coalgate
Atoka
ARDMORE
Ringling
Tishomingo
SHEPPARD 3
JE
KF
Madill
34°
Nocona
DENISON
Bowie
Van Alstyne
11
15

in Gulf moisture in low level southeasterly flow generating low ceilings, high winds, freezing precipitation (much of the season) and possible severe weather along the warm front and in warm sector squall-lines. A polar outbreak will also follow these systems. In the spring, severe weather is also a problem along quasi-stationary fronts. Any summer cold front may generate thunderstorms especially in the afternoon. Air mass thunderstorms may occur in certain continental weather patterns especially if there is a trough aloft present.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Cold fronts are likely to be weak or inactive. There are no well-defined forecast problems with this type.

b. Type B: Cold fronts with this type are mP and contain at worst brief category D middle clouds. Northwest post-frontal winds gust to 25 knots when fronts are fast moving.

When a stagnant high lies in the lower Mississippi Valley, southeast flow from the Gulf may draw in some moisture. If pressures are falling behind the high in the lee of the Rockies, category B or C stratus may move into Oklahoma. Stagnant highs of this type are typical in zonal upper air patterns such as Type B.

If the front becomes quasi-stationary across Oklahoma, there will be no prolonged bad weather unless the pattern stays in existence for several days. Eventually overrunning can become set up and bring the whole area down in stratus and drizzle.

c. Type C: The California Low pattern is fairly consistent in the northern half of the U.S. but not in Oklahoma. There are several possibilities.

(1) Southwest flow aloft over warm surface air: Early and late in the season, southwest flow overlays Gulf air moving towards lower pressure in the lee of the Rockies. The quasi-stationary front which extends northeastward from the Four Corners normally lies over the Central Plains. In such a case, expect brief category D stratocumulus ceilings late at night and in the morning. Clouds higher up will be extensive but in category E. If temperatures are unseasonably warm as is often the case, showers and thundershowers will develop on any waves that move along the front and in squall-lines south of the front. Category C and D ceilings are likely in thunderstorms. If the front is stationary across Kansas, that is close enough for the TIK area to be affected.

(2) Southwest flow aloft over cold air on surface: If the high in southern Canada drifts southeastward, the quasi-stationary front may move into Oklahoma or north Texas providing the usual conditions for a polar outbreak. Overrunning warm air begins to show up as category D middle clouds. Increasing southerly moist flow leads to stratus ceilings and freezing rain or snow. Expect category B ceilings and D visibility in light persistent precipitation. Heavier snow reduces conditions by one more category. The pattern can last for days.

d. Type D:

(1) Southerly Flow into the low: Category B or C stratocumulus or stratus forms ceilings east of the developing warm front surface. This occurs mostly at night and in the morning as Gulf moisture moves through eastern Texas into Oklahoma. These clouds advect at a predictable rate and are intensified by increased uplift north of Dallas. Low conditions will persist until either the warm front passes or the low is to the Mississippi River.

(2) Polar outbreaks: The cold front following the low will be moderate intensity. Northerly winds to 30 knots with category B stratus and light freezing precipitation or snow last for at least 12 hours.

e. Type E: The Texas Low may develop anywhere from the Panhandle to the Texas Gulf area. The track of the low is towards the St. Lawrence River. Because the development area is so large, the weather of this system is handled by the different portions of the wave.

(1) Warm front: The observed development of the warm front will vary greatly from case to case. Expect category B nimbostratus with D visibility, widespread light rain or snow and occasional B category visibility in heavy precipitation. Pre-frontal winds are east-northeasterly and gusty. Weather improves rapidly after frontal passage.

(2) Cold Front: This may be a strong polar outbreak. See Type D (2) above and add six more hours. As the high cell or ridge eventually moves to the southeast, cold air moving over moist ground may cause category B stratus if the flow is over 10 knots. Light winds are conducive to fog development late at night near the base or over the Reservoir.

(3) Warm Sector: Southerly or southwesterly flow gusts to 25 knots with patchy stratocumulus. The real problem is development of a pre-frontal squall-line in the afternoon.

(4) Texas Low Passing Southeast of TIK: Because of the northerly location of TIK, this low often tracks south

of the station. Weather near the low resembles a warm front. Category C ceilings and light to moderate precipitation should begin as the low moves out of the Gulf area or central Texas and persist until the low is due east. Backwash stratus will be category B or C, and winds will become northwesterly. Light freezing precipitation or snow will be the rule. Conditions rapidly improve as the low crosses the Mississippi River.

f. Type E_8: The Gulf Wave may produce category D middle clouds in Oklahoma until it moves eastward.

5. SEASONAL FORECAST RULES:

WINTER:

a. Polar outbreaks tend to move towards Oklahoma in a peculiar manner, accelerating by day and slowing at night.

b. Freezing precipitation is most likely when moist southwest flow aloft overrides a cold polar ridge in Texas. Visibility is characteristically two categories better than ceilings.

c. When a Texas Low develops in the Panhandle, a preferred location for warm-frontal development is at the snow line and where temperatures are near 25-35°F.

SUMMER:

a. Air mass thunderstorms require a deep middle level moisture profile and instability. Activity is isolated, favoring no particular area and is most likely in the afternoon.

ALL SEASONS:

a. Pressure gradient wind speeds may be forecast by the rules:

Southwest Gusts: GAG-MCL X 4.5 (pressure difference)

Southeast Gusts: HBR-TUL X 5.0

b. Moist Gulf air comes from the southeast to south-southwest. Southwest flow is dry and subject to some downslope motion though an influx of stratus into west Texas may turn anticyclonically northeastward and affect central Oklahoma.

VANCE AFB (END) FORECAST GUIDE

1. UNITS SUPPORTED: 71st FTW (T-37, T-38)

2. PHYSICAL DESCRIPTION AND LOCATION: Vance Air Force Base is located 5 miles southwest of Enid, Oklahoma in a steppe climate area similar to the surroundings of IAB and TIK. The elevation of the field is 1,307 feet MSL, and the active runway is oriented 35-17. The local terrain is such that wind flow from the southeast through northeast is upslope, downslope from southwest through northwest and essentially neutral in other directions. There are no significant local pollution sources.

3. PECULIAR FORECAST PROBLEMS: See TIK and IAB Forecast Guides.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the TIK Forecast Guide.

5. SEASONAL FORECAST GUIDES:

SUMMER

a. Do not forecast ceilings below 10,000 feet and /or visibility below six miles with air mass thunderstorms unless they are in close proximity to Vance (within 10-20 miles).

b. Do not forecast a change in category any earlier than two hours before it is expected to affect the base.

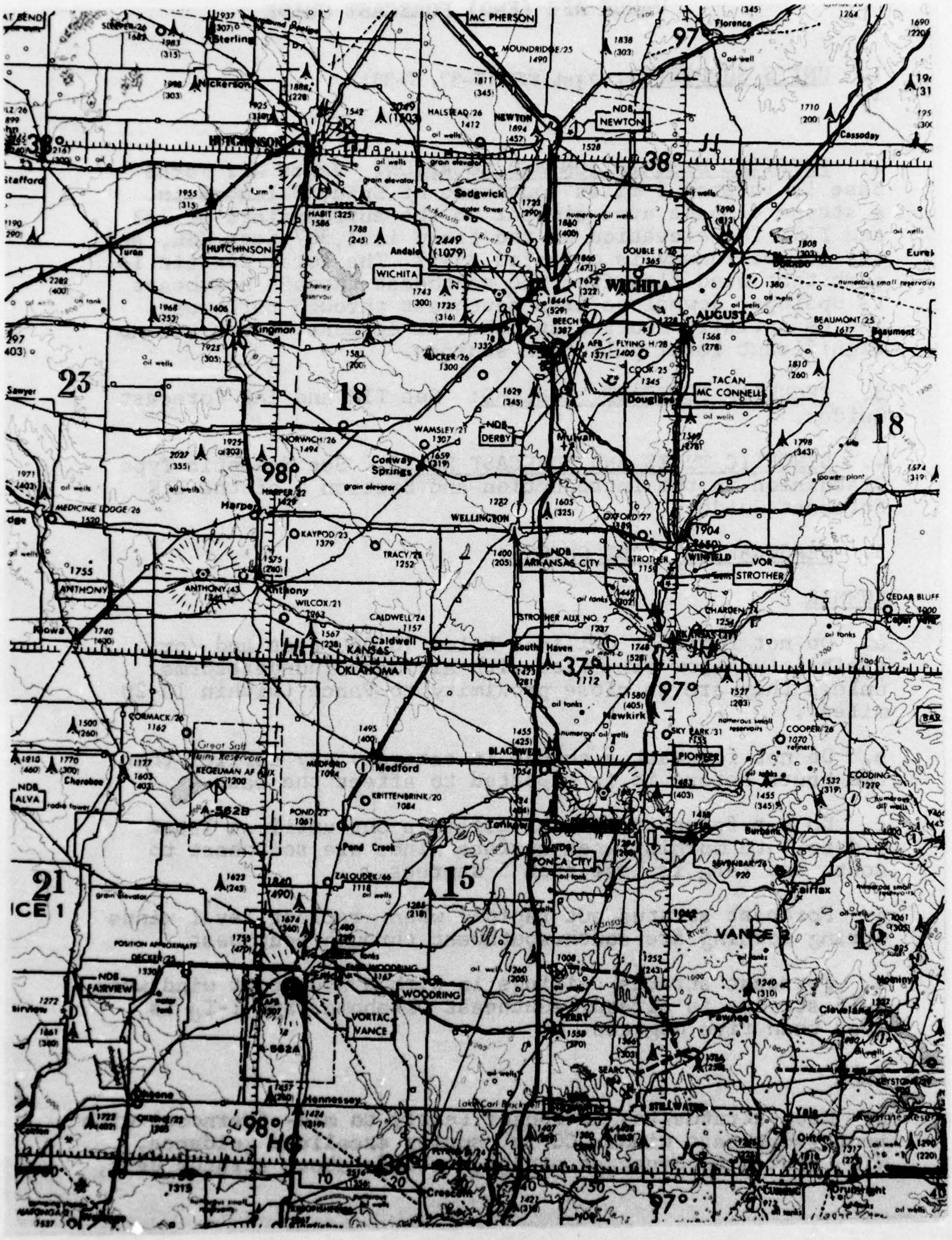
c. Do not forecast stratus ceilings out until at least mid to late morning when surface winds are southeast to south and $T-T_d$ is less than 5 degrees.

d. Forecast stratus out rapidly when gradient level winds during morning are south-southwest through southwest.

e. Forecast stratus ceilings in with a southeast wind when Gulf stratus is already southeast Oklahoma, and $T-T_d$ is less than five degrees.

FALL

a. Keep stratus/fog in longer (early to mid-afternoon) with south-southeast winds. CC is usually excellent guidance. With broken to overcast mid/high clouds above stratus deck,


MC PHERSON
Florence
Sterling
Nickerson
HUTCHINSON
NEWTON
Cassoday
Stafford
Sedgwick
Andale
WICHITA
AUGUSTA
BEAUMONT/25
Kingman
MC CONNELL
Douglass
DERBY
Mulvane
Conway Springs
Harper
WELLINGTON
MEDICINE LODGE/26
ARKANSAS CITY
WINFIELD
STROTHER
ANTHONY
Anthony
Kiowa
Caldwell
KANSAS
OKLAHOMA
South Haven
Newkirk
CEDAR BLUFF
Medford
Blackwell
PIONEER
ALVA
Cherokee
Great Salt Plains Reservoir
Pond Creek
Tonkawa
PONCA CITY
Burbank
Fairfax
VANCE
WOODRING
FAIRVIEW
Perry
Pawnee
Cleveland
Hominy
STILLWATER
Yale
Hennessey
Crescent
Drumright
Cushing
98°
97°
38°
37°
23
18
21
15
16

it will usually persist through afternoon.

b. Forecast upslope stratus when the wind direction is between 030-150°, and $T-T_d$ is less than six degrees. With winds from 030-150° and stratus already in existence, it will probably not even break in afternoon.

c. Gulf stratus in a southeast or southerly flow will form and persist until early afternoon.

d. Do not forecast Gulf stratus when surface winds have a westerly component.

WINTER AND SPRING

a. Always use the 1000-700 mb thickness analysis for forecasting snow/freezing precipitation.

b. Forecast upslope stratus with wind direction of 030-150° and a $T-T_d$ of less than six degrees.

c. Do not forecast Gulf stratus when surface winds have a westerly component.

d. Stratus ceilings will be less than 1,000 feet, and they will not dissipate during the afternoon if the conditions of (b) above are present.

e. See Fall (c) rule.

McCONNELL AFB (IAB) FORECAST GUIDE

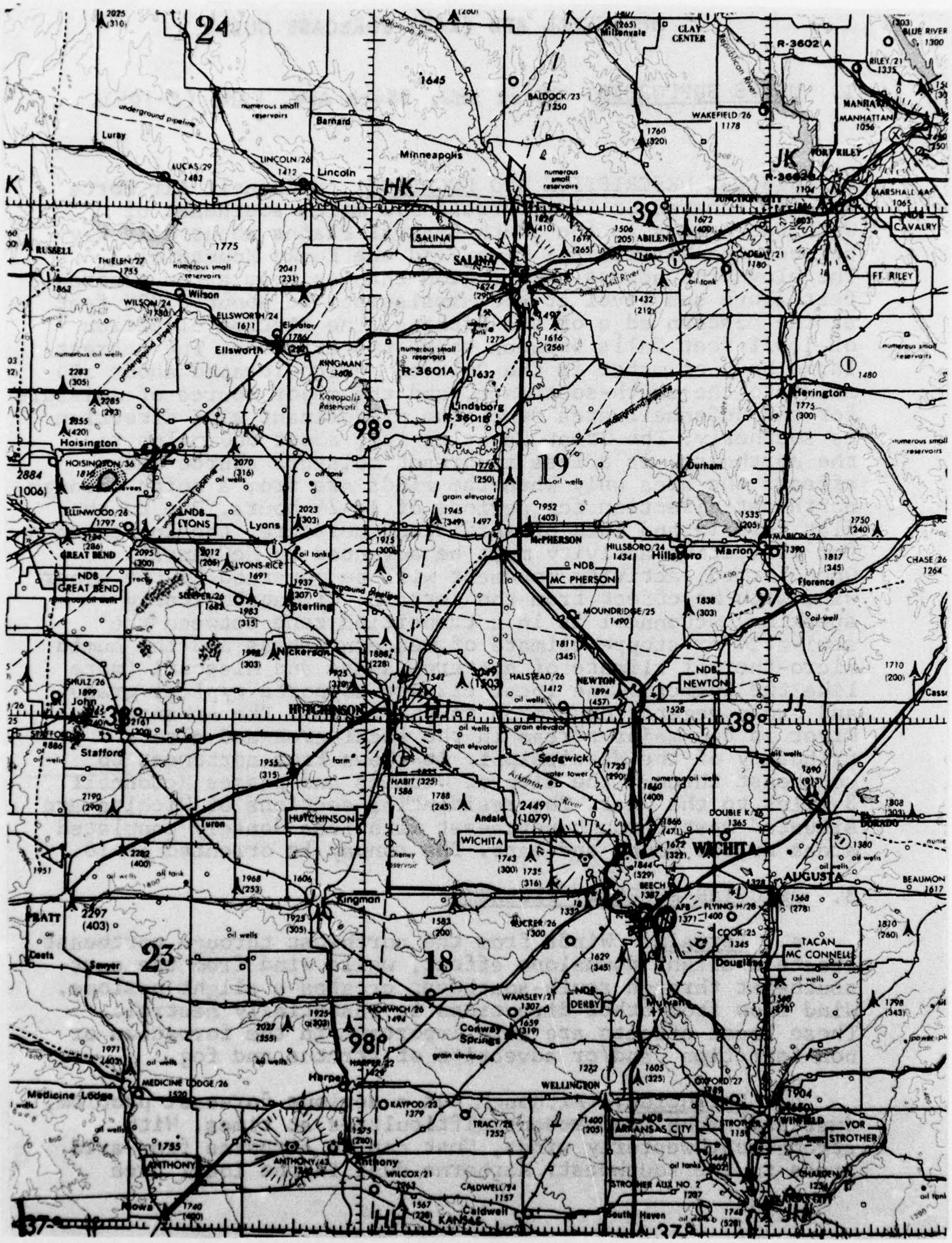
1. UNITS SUPPORTED: 381st SMW, 384th AFW, KANG (F-105).

2. PHYSICAL DESCRIPTION AND LOCATION: McConnell Air Force Base is located on flat terrain 5.3 miles southeast of Wichita, Kansas in the South Central Plains about half way between the Mississippi River and the Rocky Mountains. The elevation across this region changes from a few hundred feet above sea level at the Mississippi to about 6,000 feet at the eastern edge of the Rockies. The station elevation of 1,371 feet falls between these two extremes. The nearest large body of water is the Gulf of Mexico located about 500 miles to the south-southeast, and the major source of moisture for the McConnell area since the predominant wind direction is southerly. The Great Lakes region, about 600 miles to the northeast, is a less important moisture source and affects the area only when the winds are from a north through northeast direction for periods of 12-24 hours. Due to the flat terrain and lack of sufficient moisture, the ingredients for convective activity must be advected to McConnell. Once formed, activity movement will be governed by the upper wind with no effect from the terrain. Climatologically speaking, McConnell is in a transition zone between the semi-arid or steppe climate of western Kansas and the humid micro-thermal climate of eastern Kansas and Missouri (more like the former). The local climate supports typical grass and grain vegetation common to the Plains. The Arkansas River is the major stream in the local area and also a tributary of the Mississippi. It flows from northwest to southeast through the city of Wichita and passes McConnell 3 miles to the west. The residential sections of Wichita are situated west through northeast with less densely populated areas to the south and east. The runway is oriented 36-18.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Winds from the northwest through northeast create a slight downslope effect, while wind from the east-southeast through south-southwest creates a slight upslope. Wind flow from other directions is essentially neutral. These local effects are very important in the formation or non-formation and/or advection of stratus and fog.

b. Pollution: Although not a serious forecast problem, dust and smoke can present difficulties at times. With strong southwesterly winds, dust can be airborne from arid areas to the southwest. Airborne dust in the local area



24
Lucas
Lincoln
Minneapolis
HK
BALDOCK/23
WAKEFIELD/26
CLAY CENTER
Milonvale
R-3602 A
MANHATTAN
FORT RILEY
JK
MARSHALL AAF
CAVALRY
RUSSELL
Wilson
SALINA
ABILENE
FT. RILEY
ELLSWORTH/24
Ellsworth
KINGMAN
R-3601A
Lindsborg
R-3601B
Herington
98°
19
Hoisington
HOISINGTON/36
Durham
LYONS
Lyons
McPHERSON
HILLSBORO/24
Hillsboro
Marion
GREAT BEND
LYONS-RICE
MC PHERSON
Florence
97
Sterling
MOUNDRIDGE/25
Nickerson
HALSTEAD/26
NEWTON
HUTCHINSON
38°
Stafford
Sedgwick
Turon
Andale
WICHITA
Cheney Reservoir
AUGUSTA
BEECH
Kingman
PRATT
23
18
TACAN
MC CONNELL
Sawyer
DERBY
Douglass
NORWICH/26
WAMSLEY/27
Conway Springs
98°
HARPER/22
Harper
Medicine Lodge
MEDICINE LODGE/26
WELLINGTON
KAYPOOD/23
TRACY/23
ARKANSAS CITY
WINFIELD
STROTHER
ANTHONY
Anthony
CALDWELL/24
Caldwell
WILCOX/21
STROTHER AUX NO. 2
South Haven
Kiowa
HH
KANSAS

presents no problem. Smoke is confined to the northwest sector such that only winds from that direction reduce visibility. If the wind is over 7 knots, a restriction is unlikely.

c. Diurnal Variations: (Applies to END also)

(1) Low cloud: When the thickness of the low-level moisture is equal to or greater than 3,000 feet, the low cloud bases gradually lower from 2 hours prior to sunset through the night. Conversely, if there is a lack of moisture aloft and sustained mixing or convective lifting of the moisture to condensation level takes place, the skies will generally clear approximately 2 hours after sunset. Low clouds normally lift or burn off from 4 hours after sunrise until the time of maximum heating (2-3 hours after noon). There is generally not much clearing or lifting of the low clouds if higher broken or overcast clouds are present.

(2) Middle Cloud: The middle clouds parallel the daily frequency of thunderstorms. Cloud coverage is determined by the location of the thunderstorms. When the activity is located to the west, the cloud cover will approach broken conditions during the first 2-3 hours after sunrise. By noon, the cloud deck will have disappeared.

(3) Winds: In the absence of a definite pressure gradient, winds tend to back 20-30 degrees and decrease 5-10 knots at sunset and veer again 2 hours after sunrise. During the night, the low levels will be stable except during cold advection. Gradient wind direction is a good indicator of surface direction; six-tenths of the gradient wind for speed during daylight hours.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: As the Alberta Low moves into the Lakes area, the trailing cold front may drop southward past IAB.

(1) Clouds: Scattered to broken high. Some stratus may form in hours right around sunrise if front passes.

(2) Visibility: Unlimited. (3) Precipitation: None

(4) Winds: SSW 5-10 may shift to NE-ENE 10-15 after front.

b. Type B:

(1) Clouds: Forecast low category E middle clouds and broken high clouds. If sufficient moisture is forecast from Gulf, consider category C stratocumulus.

(2) Visibility: Unrestricted, although category D is remotely possible in light precipitation.

(3) Precipitation: Very light, usually trace. If a wave forms on the front a couple of inches of snow can occur, but wave must pass to the south of the station.

(4) Winds: S 15-25 with higher gusts shifting to WNW 10-20 then abating.

c. Type C: Stationary front through central Plains may be either north or south of IAB (critical location). Waves moving through flow and along front increase clouds and precipitation.

(1) Clouds: Front north of IAB will cause diurnal stratus and stratocumulus in flow off Gulf. Front south of IAB will cause basic category C ceiling with periods of B in precipitation.

(2) Visibility: Unrestricted except at sunrise when six miles is likely. If front is south, expect C or D category visibility, worse if drizzle occurs.

(3) Precipitation: Drizzle, possibly freezing, when front is south. Thunderstorms may form in lines perpendicular to front supported by waves. Front north, no precipitation except in showers.

d. Type D: Major Plains storm. Track is absolutely critical to IAB forecast. Usually the center goes over or north of the station.

(1) Clouds: If wave is south, expect category B stratus. If north, some clouds will precede warm front but then clearly improve until squall-line/cold front arrives. Expect D category stratocumulus behind cold front.

(2) Visibility: Unrestricted at first, deteriorating to B or C in precipitation. If wave north of station, expect rapid improvement until cold front with reduction to C or D in showers for brief periods.

(3) Precipitation: Unless cold air already covers the Plains, it will begin as rain or drizzle changing to snow as the system goes by to the southeast and east. If cold air is already over the station, expect freezing precipitation with a possibility of heavy snow following. With wave north of the station, expect rain and/or thunderstorm activity ahead of warm front and then again with cold front.

(4) Winds: Wave north; SE 10-20 shifting to WNW 15-20. Wave south; NE 10-20 slowly backing to NW 15-25 higher gusts.

e. Type E: Cold arctic outbreak will pass station.

(1) Clouds: Category D or C ceilings in light precipitation as wave moves out of Texas. Will persist until cold air is established due to lift and instability.

(2) Visibility: Category D in light precipitation with rapid improvement behind cold front.

(3) Precipitation: Light snow or showers as wave moves out of Texas. May not snow at all if wave is too far south or area of precipitable water is small. Precipitation ends after cold front passes normally. Cold air thunderstorms have occurred once in a great while with this type.

(4) Winds: NE 5-10 or L/V shifting to N 15-25, higher gusts.

5. SEASONAL FORECAST RULES:

a. With the wind direction 180-270-360°, any stratus in the area will be category C around 1200 feet.

b. With the wind direction 360-090-180°, any stratus in the area will be between 500 and 1,000 feet.

ALTUS AFB (LTS) FORECAST GUIDE

1. UNITS SUPPORTED: Military Airlift Wing (C-5, C-141). Freezing precipitation is of particular concern. 11th ARS is a tenant unit assigned to the base.

2. PHYSICAL DESCRIPTION AND LOCATION: Altus Air Force Base lies 150 miles southwest of Oklahoma City and 75 miles northwest of Wichita Falls, Texas. The land west begins to rise from 1,500 to 3,500 feet in 100 miles from southwest to northwest. Beyond 25 miles east, the Wichita Mountains rise to a maximum of 2,600 feet. The land is otherwise arid and nearly flat. The Gulf of Mexico is 500 miles southeast of Altus, and moisture which reaches stations a short distance away may not make it this far. Field elevation is 1,378 feet, and the runway is oriented 17-35.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Upslope flow from the southeast produces the same stratus and fog as at local stations further east, but the more westerly location and higher elevation reduces the likelihood. Downslope from the northwest helps dissipate post-frontal clouds, and compressional heating will actually raise temperatures (only when flow is from southwest to northwest). Altus lies above the Red River Valley, so the effects are minor. There are no significant pollution sources.

b. Transient Controls: See TIK Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See the Synoptic Type Discussion in the Introduction and the TIK Forecast Guide.

5. SEASONAL FORECAST RULES: See also the TIK and FSI Forecast Guides.

a. Summer: There is a "dry line" that develops in the Panhandle to the west and moves eastward in the afternoon. This north-northeast to south-southwest line may generate afternoon thunderstorms in two situations. First, if a cold front moves in from the northwest, the dry line precedes it and a squall-line may develop along it. Second, moist Gulf air and divergence in the ridge aloft produce lower levels of activity.

FG
GG
Canton Lake
CANTON/27
Canton
OKEENE/22
Putnam
Leedey
Roll
Watonga
KINGFISHER
Geary
Butler
Custer City
NDB FOSS
NDB CLINTON
Clinton
STAFFORD
Hinton
Wheeler
Sayre
SAYRE
Erick
Elk City
BURNS FLAT
Cordell
CLINTON-SHERMAN
MIGNON LAIRD
HADDOCK/26
Briscoe
Carnegie
ANADARKO
Anadarko
FF
GF
Granite
HOBART
Hobart
Wellington
Mangum
Blair
Apache
NORTH FORT SILL
TACAN ALTUS
ALTUS
Altus
Snyder
Hollis
Olustee
Eldorado
Tipton
SHEPPARD 1
LAWTON
Lawton
Fort Sill
NDB BROWN
NDB POST
NDB FREDERICK
Frederick
CHATTANOOGA SKY HARBOR
CHILDRESS
Quanah
Chillicothe
WILBARGER
Vernon
Davidson
Grandfield
OKLAHOMA
TEXAS
SHEPPARD 2
FE
GE
TRIANGLE
LOCKETT/26
Margaret
Crowell
FOARD/22
WICHITA FALLS
Wichita Falls
TACAN SHEPPARD
SHEPPARD AFB WICHITA FALLS
KICKAPOO
LAKE KEMP
Diversion Lake
MYERS
Walters
HALLIBURTON
100°
35°
27
22
26
99

b. Winter: Post-frontal stratus is present to the rear of the front to about 100 miles in the cold cP air. Formation of stratus at LTS is tied to the wind direction. If the wind in the cold air is west to north, even with stratus upstream, enough of a downslope exists to cause dissipation as it moves in. But if the surface wind has an easterly component, stratus will move in with the approximate speed of the wind at the gradient level.

FORT SILL -POST AAF (FSI) FORECAST GUIDE

1. <u>UNITS SUPPORTED</u>: US Army Field Artillery, US Army 3rd Corps.

2. <u>PHYSICAL DESCRIPTION AND LOCATION</u>: Post Army Airfield is located in southwest Oklahoma City and 55 miles north of Wichita Falls, Texas. The airfield is part of Fort Sill which lies just north of Lawton and just southeast of the Wichita Mountains. The Gulf of Mexico is 450 miles southeast, and there are no hills as high as 3,000 feet for over 200 miles in any direction. Field elevation is 1,187 feet, and the runway is oriented 18-36.

3. <u>PECULIAR FORECAST PROBLEMS</u>:

a. <u>Terrain</u>: The Wichita Mountains affect Fort Sill in several ways. Thunderstorms moving in from the west or west-southwest tend to turn to the left or in a more northerly direction, passing over the mountains rather than over the airfield. In general, thunderstorms and showers appear to be more numerous and heavy over these hills northwest of Post. Clouds and winds from the general direction of south are mildly affected by the Wichitas in that winds appear to be slightly weaker than forecast, and gaps in the cloud banks may appear in the lee of the hills. In all other respects, Fort Sill resembles the Tinker and Sheppard area. There are no locally significant pollution sources.

b. <u>Transient Controls</u>: See TIK Forecast Guide.

4. <u>SYNOPTIC TYPES AND FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction and the Section 4 of TIK Forecast Guide.

5. <u>SEASONAL FORECAST RULES</u>:

<u>Summer</u>: Thunderstorms developing in the Panhandle will likely dissipate as they move towards Fort Sill unless they are supported by a sharp short wave trough aloft. Even then, many go around the Wichitas and Fort Sill to the north or south.

<u>Late Fall through Early Spring</u>: FSI strongest gradient winds are produced by the passage of a polar or arctic outbreak or a fairly strong Pacific front. These northwesterly to northerly winds are affected in a peculiar way by the Wichita Mountains. When the gradient in strong enough to produce surface gusts of 25-35 knots, Fort Sill will generally get stronger winds than neighboring stations

SAYRE
BURNS FLAT
HOBART
NDB CLINTON
22
FF
GP
35
Wellington
Mangum
Blair
Hollis
TACAN ALTUS
ALTUS
NORTH FORT SILL
WICHITA MOUNTAINS
NDB BROWN
Snyder
Olustee
26
Eldorado
Tipton
SHEPPARD 1
Lawton
LAWTON
NDB POST
NDB FREDERICK
FREDERICK
CHATTANOOGA SKY HARBOR
100°
CHILDRESS
Quanah
Chillicothe
Vernon
Margaret
GE
FE
OKLAHOMA
TEXAS
SHEPPARD 2
Crowell
WICHITA FALLS
TACAN SHEPPARD
KICKAPOO
LAKE KEMP
Diversion Lake
SHEPPARD 4
Seymour
Archer City
LAKE KICKAPOO
Benjamin
20
16
Knox City
Munday
SHEPPARD 5
Throckmorton
Jermyn
99

(especially those to the north such as CSM and HBR which are used to estimate peak wind with frontal passage at FSI). However, when the gradient is strong enough to produce surface gusts to 40-55 knots, FSI winds are usually less than those at surrounding stations. The explanation for this contradiction is that the mountains channel fairly strong winds down to the surface in a semi-laminar fashion. When the gradient wind is extremely strong, the mountains act more as a buffer, and the flow becomes more turbulent.

Fall-winter-spring: Gulf stratus is a problem during all seasons except summer but presents the greatest problems during winter.

a. Generally, the first day is difficult to pick up, but once the stratus occurs it will continue daily until a significant synoptic change such as dry southwesterly flow or frontal passage occurs.

b. FSI often gets Gulf stratus before SPS because of the downslope into the Red River and subsequent upslope into southwestern Oklahoma.

c. Stratus ceilings of 1,000-2,000 feet in existence will generally drop below 1,000 feet by 14-15Z and lift again from 17-18Z.

d. There is no simple rule for how quickly stratus ceilings will lift and/or break out. If there is no major synoptic change, the depth of the moist layer, thickness of the clouds and existence of significant mid and upper-level cloud decks determine the speed of lifting or dissipation.

ALL YEAR: Surface winds only occasionally reach 30 knots when the gradient wind is southerly or southwesterly. In this situation, maximum gusts at TIK, SPS and LTS generally run 3-5 knots higher. A low-level (3,000-5,000 feet) nocturnal jet often forms in the area. If the 12Z jet maximum is located in southwest Oklahoma, it will produce the strongest surface winds in central and northern Oklahoma because the jet maximum migrates upstream. Therefore, a low-level jet maximum located 100-200 miles upstream from Ft. Sill at 12Z is most conducive to strong surface winds at Ft. Sill when southerly or southwesterly gradient flow exists. Furthermore, the low-level jet generally decreases in intensity during the daylight hours. It is necessary to mix it to the surface as soon as possible during the day in order to get gusts to 30 knots. Thus, any forecast cloud cover which will significantly inhibit surface heating is likely to similarly inhibit strong gusty surface winds.

Winter:

a. After active cold fronts pass and skies clear in the general area, cumulus will persist over the Wichitas in northwest flow.

b. Category C stratus is likely the next morning if stratus is reported up the Rio Grande as far west as Del Rio (DLF or DRT).

SHEPPARD AFB (SPS) FORECAST GUIDE

1. <u>UNITS SUPPORTED</u>: 80th FTW (T-37, T-38)

2. <u>PHYSICAL DESCRIPTION AND LOCATION</u>: Sheppard Air Force Base is located in extreme north central Texas, a mile north of Wichita Falls and just south of the Oklahoma border at the Red River. Sheppard lies on the Osage Plains, a large area of undulating scrubland extending from near the border with Oklahoma southward across Texas for at least 100 miles. The base elevation is somewhat low for the area, because the base is in the east-west oriented Red River Valley (a shallow trough no more than 200 feet below local hills). There are no hills as high as 3,000 feet for over 200 miles in any direction. The Gulf of Mexico is 400 miles southeast at its closest point. Moist air is lifted to 1,500 feet halfway to Sheppard then drops off to the field elevation of 1,015 feet within 30 miles. The dual runways are oriented 15-33 with an alternate 17-35.

3. <u>PECULIAR FORECAST PROBLEMS</u>:

a. <u>Terrain</u>: Sheppard is well west of the climatological dry line that extends north-south in eastern Texas. The climate is therefore arid with most precipitation coming from spring and summer thundershowers associated with fronts. Air mass activity is said to be influenced in a minor way by local reservoirs, one of which is Lake Arrowhead 15 miles south-southeast of the base. The lake is too far off to influence the base as far as fog formation is concerned. Therefore, neither Lake Arrowhead or the Red River are clearly moisture sources. There are low hills north and south of the base, but they are of no concern. The slightly lower elevation of Sheppard keeps stratus ceilings slightly higher than would be otherwise indicated but only by a factor of 100 feet or so. There are no significant pollution sources.

b. <u>Transient Controls</u>: See TIK Forecast Guide.

4. <u>SYNOPTIC TYPES AND FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction and Section 4 of TIK Forecast Guide.

5. <u>SEASONAL FORECAST RULES</u>: See TIK and FSI Forecast Guides and note the following.

KINGFISHER
Butler
Custer City
CLINTON
MDB CLINTON
FOSS
STAFFORD
Geary
22
Hinton
MUSTANG
OKLAHOMA
Wheeler
SAYRE
BURNS FLAT
Cordell
Erick
HADDOCK 26
Sentinel
HOBART
Carnegie
ANADARKO
FF
GP
Granite
HOBART
Wellington
Mangum
Blair
NORTH FORT SILL
Apache
Hollis
TACAN ALTUS
ALTUS
Snyder
Cache
NDB BROWN
Olustee
SHEPPARD 1
LAWTON
Tipton
26
CHILDRESS
100°
Eldorado
FREDERICK
NDB FREDERICK
CHATTANOOGA SKY HARBOR
Walters
Comanche
Quanah
Chillicothe
WILBARGER
Davidson
GRANDFIELD
Grandfield
OKLAHOMA
TEXAS
SHEPPARD 2
Vernon
FE
GE
A-636
TRIANGLE
Margaret
LOCKETT 26
Electra
Crowell
34
WICHITA FALLS
TACAN SHEPPARD
Truscott
LAKE KEMP
Diversion Lake
KICKAPOO
Henrietta
MYERS
SHEPPARD 4
LAKE KICKAPOO
Benjamin
Seymour
Archer City
20
16
Knox City
Munday
Megargel
98°

SUMMER:

a. The source regions of air masses are the Gulf of Mexico and the Desert Southwest. Frontal activity is almost non-existent.

b. In the early summer, dry lines form in northwest Texas but rarely reach east to Sheppard. Thunderstorms are associated with the dry line.

c. Inverted troughs on the surface occur during the late summer. If there is sufficient moisture, low ceilings and visibility will result when the trough is within 100 miles of Sheppard.

d. Broken cumulus clouds form and move into the area from central Texas. Abundant moisture must be present in the mid-levels, and the surface temperature must be between 80-92^{o}F.

FALL:

a. Air masses in the fall are similar to summer but add cP in the late fall. Cold fronts occur more often and move through Sheppard rapidly with some cold air stratocumulus 2-3 hours behind passage, gusty surface winds of 30 knots or greater but little if any precipitation.

b. Cold fronts approaching from the west are often preceded by Gulf stratus.

c. Freezing precipitation occurs in late fall with a cP air mass at the surface and overrunning of warm moist air from the Gulf.

WINTER:

a. mP and cP air masses predominate. Cold fronts move as in late fall. Stratus behind front breaks after the ridge-line moves over or east of SPS.

b. With a Type E system when low passes to the south of the station, significant snow will occur especially if closed system follows aloft.

c. Freezing precipitation occurs with a cP air mass on the surface and overrunning of warm moist air from the Gulf.

d. A low-level jet is sometimes present with a mean direction of south-southwest and a speed greater than 35 knots.

SPRING:

a. mT and mP air masses with an occasional cP are the rule. Most frontal activity arrives from the west with squall-lines 100-200 miles in advance producing severe weather in some cases.

b. Dry lines are active in the spring and reach Sheppard more often than during the summer. Squall-line activity is often observed along the line.

c. Type D and B systems are common in the spring and are preceded in most cases by a strong lee-side trough in eastern New Mexico or west Texas. The trough forces the surface winds into the southwest, and the speed is apt to exceed crosswind limits for training aircraft.

d. The low-level jet sets up in spring and is most frequently south-southwest in direction and greater than 35 knots.

REGION 12

CENTRAL AND EAST TEXAS FORECAST GUIDES

Carswell AFB . . . . FWH
Hensley Field (Navy Dallas) . . . . . NBE
Grey AAF - Fort Hood . . . . GRK
Bergstrom AFB . . . . BSM
Kelly AFB . . . . SKF
Randolph AFB . . . . RND
Laughlin AFB . . . . DLF
Ellington AFB . . . . EFD

CARSWELL AFB (FWH) FORECAST GUIDE

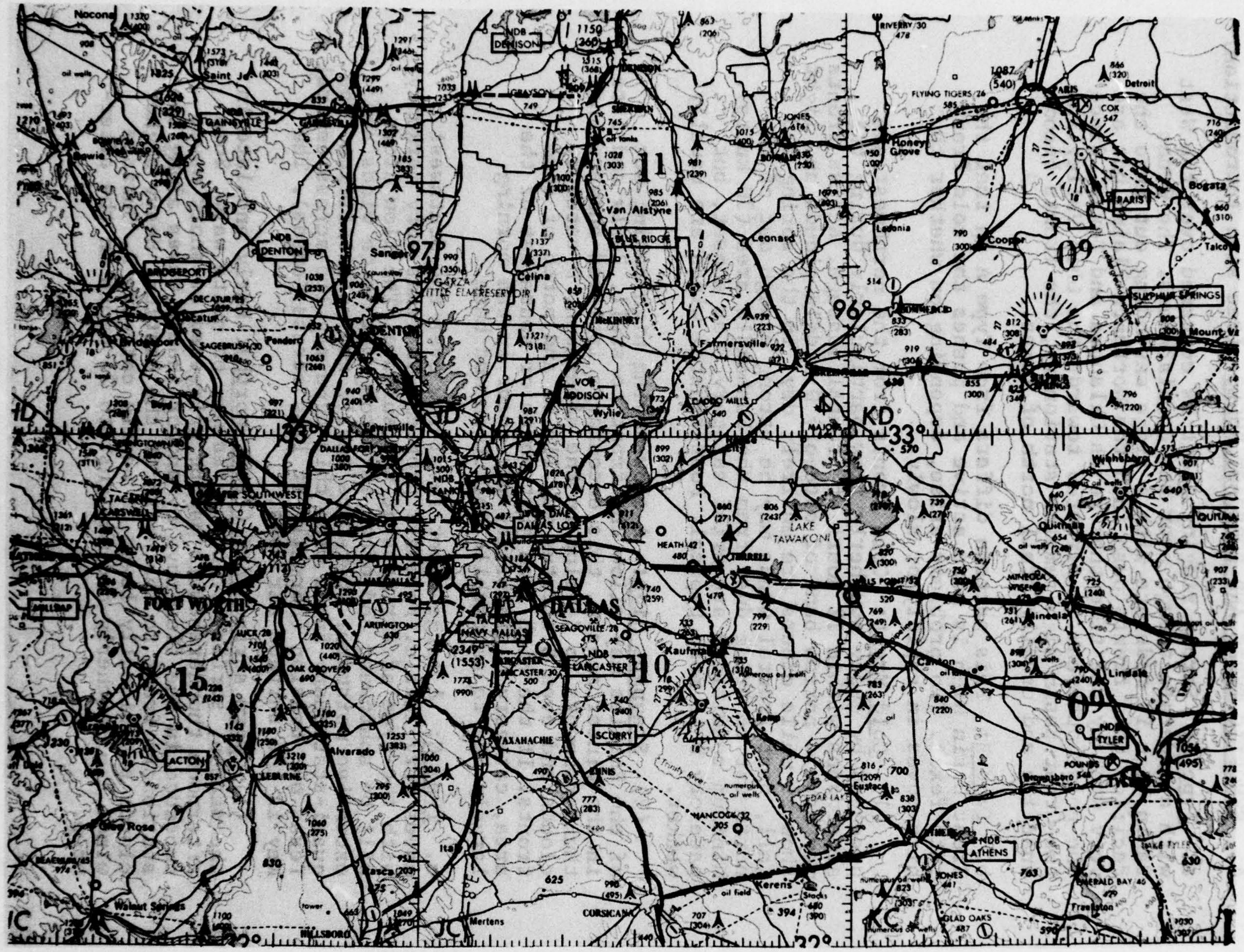
1. UNITS SUPPORTED: 7th Bomb Wg (B-52, KC-135)

2. PHYSICAL DESCRIPTION AND LOCATION: Carswell Air Force Base is located in north central Texas 5 miles west-northwest of Fort Worth and 30 miles west of Dallas. Fort Worth has nearly assimilated Carswell, but there are some open spaces to the west. Lake Worth lies off the north end of the airfield. There are other reservoirs beyond 5 miles north and south. The Fort Worth-Dallas area has over 1,250,000 people, so the base is definitely not in a rural setting. These cities lie on the flat "Grand Prairie". Low hills begin at a point 25 miles west, and the land generally begins to rise beyond that. The Gulf of Mexico is 250 miles southeast at its closest point. Field elevation is 650 feet, and the runway is oriented 17-35.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Carswell's flat locality is not problem-free because the land does rise to the west. Downslope conditions exist with west and north winds which dry out the air and also keep cloud bases higher than points to the northwest. To the west, the low complex of hills near Mineral Wells (45 miles away) seems to be a center for thunderstorm activity, and the hills are well-placed to allow squall-lines to move toward Carswell. Stratus off the Gulf of Mexico is a forecast problem much of the year. Lake Worth may have fog on it at sunrise which may drift over the field in a light northerly breeze. The other reservoirs are of little consequence. Urban pollution is becoming a forecast problem during periods of stagnation, although industry is not yet a major contributor. In the spring, fronts from the northwest may be accompanied by dust.

b. Transient Controls: Winter cold fronts include the relatively dry mP and cP types. mP fronts produce a narrow band of clouds and may generate dust storms in the spring or fall. cP fronts precede arctic outbreaks that may bring a lot of stratus and freezing precipitation. The most significant storms are developing Gulf waves and Panhandle lows which may develop anywhere in Texas and cause a variety of important forecast problems. Return flow around anticyclones draws in stratus from the Gulf once the high cells are east of Texas. The stratus inflow is persistent in the winter and spring. Air mass thunderstorm activity is isolated throughout the summer, mostly forming in the afternoon or again late at night. The most intense storms are associated with frontal activity and warm sector instability lines.



DALLAS
FORT WORTH
NDB DENTON
NDB TYLER
NDB ATHENS
PARIS
SULPHUR SPRINGS
LAKE TAWAKONI
ACTON
WAXAHACHIE
CORSICANA
HILLSBORO
NDB DENISON
ARLINGTON
BLUE RIDGE
SCURRY
NDB LANCASTER
BRIDGEPORT

4. SYNOPTIC TYPES AND FORECAST RULES: (See also Introduction)

a. Type A: Strong ridging aloft is centered over the West with a moderate trough over the Appalachians. The Great Basin High is moderate with a ridge extending out into the Pacific. Cold fronts push into the Northern Plains but are very weak by the time they reach Oklahoma and Texas. Since the polar outbreak is directed towards the Ohio Valley and the Great Basin High remains stationary, the fronts become inactive and usually stall north of Texas.

b. Type B: This pattern differs from Type A in that the Great Basin High is more active and pushes the cold front into Texas. Two problems arise, depending on whether the high moves in rapidly or slowly.

(1) Cold Front: Cold fronts from the northwest are preceded by gusty southerly flow particularly during the afternoons within 12 hours of frontal passage. Active fronts may have a narrow band of category D middle clouds and light showers while others are entirely dry. In the spring and fall, post-frontal winds may be strong enough out of the northwest to bring dust from the Panhandle area (30 knots). Minimum conditions are brief category B at sunset, but category D is more typical. Post-frontal winds are usually weaker.

(2) Stagnant High: A slow-moving high coming out of the Rockies may allow the front to stall. Early and late in the winter season, this encourages isolated showers and thundershowers to develop in the afternoon. D category clouds and even B stratus may lie on and north of some fronts. If the high lies just north or southeast of the area, category D visibility may occur in the morning largely due to automobile pollution and haze.

c. Type C: A large upper level low over the Southwest moves very little. Forecast problems in Texas vary markedly with the type of air mass at the surface. The flow aloft will be southwest and often is strong with high winds and extensive moisture. There are really two possibilities. The quasi-stationary front with this type may lie across central Texas on occasion (normally it lies across Kansas). The key is the surface air mass.

(1) Warm surface air (front north): Early and late in the season, surface temperatures may be quite warm. Some afternoon thundershowers may be triggered as short waves embedded in the flow move by and/or induce waves along the stationary front to the north of the station. Heavy higher clouds occasionally lower to nearly category D. Surface winds are southerly and may gust to 25 knots in the afternoon.

(2) Cold surface air (front south): In mid-winter, swelling of the high in southern Canada may cause the cold front to slip southward past the station. If this happens, winds will be north or northeast with category B or low C stratus and possible light freezing precipitation. Visibility may lower to category C or D in heavier drizzle or rain for brief periods as waves move along the front. This pattern of overrunning is very persistent and may last well over 48 hours.

d. Type D: This low develops in eastern Colorado or northern New Mexico and crosses the central Plains. Forecast problems in Texas revolve around strong southerly inflow to the cyclone and the moderate polar outbreak which follows the system.

(1) Southerly Flow: Gusty winds (especially in the afternoon) and possible stratus inflow occur whenever pressures fall on the lee of the Rockies for any appreciable time. In strong flow, stratus is category C especially late in the season. Monitor this cloud as it passes stations to the southeast. With weaker flow, category B stratus is more likely. In such cases, stratus may persist around the clock. Late season stratus decks are apt to break up in the afternoon.

(2) Polar Outbreak: Conditions are similar to overrunning in the previous case (unless the front is moving very fast). The front may immediately cause clouds to form or they may from behind a secondary surge. In any case, expect category B stratus, intermittent freezing precipitation and northeast to northwest winds at 25 knots. Conditions may persist until the high cell is well down in the Plains. Clearing to the north may be extrapolated into Texas. If the high continues into the Gulf States, eventually return flow will be drawn back into north Texas.

e. Type E: These systems develop in Texas from the Panhandle to the Gulf. Usually arctic air lies over the Plains already and these lows develop along the border of the cold air. The low will not develop in the cold air. Both the Panhandle Low and the Texas Gulf low move up the west side of the Appalachians. In general, each sector of both cyclone types must be considered independently.

(1) Texas Gulf Low: Gulf systems may include an inverted trough extending northward over eastern Texas. The cloud shield remains over the FWH area until the low or trough is well east or northeast of the area. Fringe clouds are normally category D with accompanying surface north winds. When the low is within 500 miles south through east, category B or low C stratus, northeast winds to 25 knots and intermittent precipitation are likely. Visibility restriction is minor unless heavy precipitation occurs.

(2) Panhandle Low: The preceding arctic quasi-stationary front should be near the Texas-Oklahoma border for the low to form there. Other locations for development are eastern New Mexico (spawning a warm front that affects much of Texas) and northeast Texas (warm front north of all Texas stations). The following assumes a development in the Panhandle area.

(3) Warm Front: Fronts will vary greatly in their characteristics. Initially patchy clouds lie along the developing front. As the cyclone develops, category B clouds with D category visibility in light precipitation and fog appear. East winds may range up to 25 knots, and thunderstorms (possibly severe) may develop on the front. Cloud conditions improve markedly after the warm front passes.

(4) Warm Sector: Southerly flow will gust to 25 knots if troughing near the cold front is pronounced. Clouds are generally patchy consisting of Gulf stratus and occasional category D stratocumulus or altocumulus at night. The main problem is the development of pre-frontal squall-lines.

(5) Cold Front: Most fronts precede a moderate to strong outbreak especially in mid-winter. Weather resembles that of the Type D cold front. Keep in mind that if the front is moving fast, downslope will dissipate the ceilings shortly after frontal passage.

SUMMER

a. Type B: Southeast flow off the Gulf prevails, but air mass thunderstorm activity is isolated. Brief category D cumulus ceilings develop during the late morning and may also occur if tropical systems are in the Gulf. If a lee-side trough develops east of the Rockies, Gulf stratus in category C will be drawn over the area. Occasional weak fronts will move into northern Texas from the north (rare). Nocturnal thunderstorms which form over the Gulf do not penetrate far enough inland to affect Carswell.

b. Type E: This pattern occurs when the Bermuda Ridge is not strong enough or too far east to allow flow from off the Gulf to cover eastern Texas. Fronts do move into the area under these circumstances particularly in late summer. Such fronts encourage increased coverage of thunderstorms.

5. SEASONAL FORECAST RULES:

a. Summer: Cumulus ceilings in the late morning are likely if the 850 mb temperatures are under 20°C and the spread is less than 4 degrees. Surface dewpoints should be 70° or more. Conditions may repeat on successive days.

b. Winter: Post frontal stratus moves south at 60% of the gradient wind component. Look for cloud height and thickness in Oklahoma, since stratus over 2,000 feet AGL or less than 1,000 feet thick may not form a ceiling at FWH.

c. Winter: Gulf stratus begins 48 hours after onshore flow develops out of the southeast. Stratus advected up the Rio Grande past Del Rio (DRT, DLF) can move in with southeast flow. Troughing to the west, both on the surface and aloft, tends to deepen stratus. Surface winds over 10 knots usually raise ceiling to category C.

d. Winter: Ideal fog formation temperatures are in the range of $40^{o}F$ to $49^{o}F$.

ALL YEAR

a. Squall-lines developing over the hills 25 miles west are particularly intense when they move eastward into FWH.

b. Dust storms may develop when a deep surface low (trough) aloft moves into west Texas.

The following rules are taken from a list included with the Carswell TFRN. For more information, see the complete copy with attached maps. The following list includes all the rules which the detachment marked with "E".

CUMULUS CEILING

a. Winds east of south (160°) are moist and will often cause broken cumulus, while winds west of south (200°) are dry and cause scattered cumulus.

b. Easterly flow into Mexico or south Texas brings cumulus ceiling 48 hours later. Watch for no cumulus ahead of deep easterly flow.

c. Low-level jet (35 or more knots at 1800 feet) appearance at night over SKF will increase chance of broken cumulus during the day.

d. Often scattered Gulf stratus will become broken near 1000L and go scattered after 1800L. When there is an established inversion, the clouds will go scattered when the inversion is eliminated.

e. Cumulus bases tend to be lower than skew-T indicates; often 4000 feet near 1100L and 5000 feet near 1400L.

f. Continuity of previous day's cumulus is the best way of forecasting today's cumulus.

COLD AIR STRATUS

a. Ceilings should be anticipated when the neph indicates an overcast cloud shield extending more than 300 miles to the north of the front.

b. When the front is expected to become stationary north of AUS, the probability of cold air stratus formation increases significantly.

c. Cloud shields over Oklahoma with a thickness of 1000 feet or greater have a greater probability of being advected into FWH than thinner clouds.

d. Overcast cloud shields in Oklahoma based higher than 2,000 feet AGL generally become broken or scattered by the time they reach FWH.

e. Fronts that wave in Texas increase the possibility of prolonged cold air stratus until the wave moves east of 94W.

f. Frontal waves in the CRP region result in NE flow in FWH area, and formation of stratus below the inversion often occurs.

g. With a wave near CRP, the westerly moving low clouds over FWH tend to persist for 24 hours. If the associated low moves north, the low clouds may be expected to increase in thickness and persist for 36 hours.

h. Cold air stratus occurs most often when a weak 500 mb trough is to the west of FWH.

i. Great Plains extensive cloud shields with drizzle have a greater chance of being advected into north central Texas.

j. Fronts that bulge directly through FWH seldom result in prolonged stratus ceilings (3 hours).

k. Westerly jet streams over the central Rockies result in Chinook winds that decrease the chance of ceilings accompanying frontal passage at FWH.

GULF STRATUS (Use Carswell Gulf Stratus Study Also)

a. Modified cP air usually requires two days trajectory over the Gulf before a stratus deck influences FWH.

b. Deepening 500 mb trough on the West Coast tends to immediately increase the moist southerly low-level winds from VCT to FWH.

MIDDLE CLOUDS

a. Deepening 700/500 mb troughs that have half their trajectory over the Pacific tend to advect middle layers into FWH within 24 to 36 hours during the winter months.

b. Overcast rainy skies in Sonora (CUU), Mexico tend to advect thick altostratus layers into FWH within 18 to 24 hours during the winter.

c. Middle cloud layers over this region tend to form near the freezing level during the spring-fall.

d. Regardless of how thick the stratus deck is, the skies clear rapidly from the west with the passage of the 500 mb trough.

SNOW VERSUS RAIN

a. Cold core lows that develop in the Texas Panhandle and track to the south-southeast often result in snow over north central Texas.

b. Frontal waves in south Texas will rapidly increase clouds and result in freezing precipitation or snow when reinforced by a secondary surge of cold air.

c. See thickness rules in the Carswell TFRN.

WIND DIRECTION:

a. South-southeast winds prevail even when the isobar pattern indicates a SSW or SW wind appears logical.

b. Winds at sunrise tend to veer from SE to SSW during the day and back to SE after sunset.

c. Winds behind a Type B front are 310° about 80% of the time. Seldom do the winds become as far north as 340°.

d. Direction of winds after a cP front tend to come from the coldest air region (DDC) even when the high is displaced to the east.

WIND VELOCITY

a. South winds increase rapidly when a low deepens in the Great Plains. These winds are generally stronger than the pressure gradient would indicate.

b. When a strong (but modified) high is over north Florida, the nocturnal jet establishes itself on the inversion. These winds seldom reach the surface at FWH.

c. Gusty north winds are most prevalent when the sky is clear, and the front is expected to go all the way to Mexico.

COLD FRONTS (WINTER)

a. Backdoor forntal passage should be anticipated when the pressure at FSD is greater than RCA (very slow movement).

b. When pressure change charts indicate a very large rise in Alberta, cP fronts may accelerate to 40 knots.

c. Speed of backdoor cP outbreaks is approximately one-half the speed of typical cP outbreaks.

d. Speed of cP air masses is slower than an airmass in a closed system within the continental United States.

e. Movement is dimished and fronts tend to stall along the SPS-MLC line when the 500 mb trough is deepening in Arizona.

WARM FRONTS:

a. Waves generally form in CRP area on long trailing fronts. (Result in deteriorating FWH area weather).

b. Frontal waves occur sooner than depicted in the Gulf. Weak fronts do not move out in the Gulf as far as usually depicted on the facsimile.

SQUALL LINES

a. Squall-lines in the FWH area are most severe when associated with mP fronts which accelerate rapidly out of the Rockies until reaching the lee-side trough. Tornadoes may develop in the FWH area with this situation.

b. When squall-lines form less than 50 miles west of the FWH area, they will be severe while moving over FWH.

DUST STORMS

a. During early spring when a fast-moving mP front lifts the dust in west Texas to the 15,000 foot level, the resultant fall-out decreases the visibility at FWH to less than 1 mile (generally near sunset).

b. Droughts in west Texas determine the intensity of the dust storms that influence Carswell. During severe droughts, the visibility has been less than 1/8 mile at FWH (near sunset).

c. The first indication of a dust storm is a deepening 500 mb trough moving into west Texas. Surface winds at GDP are a key to the lowering of the jet and resultant Chinook that lifts the dust.

HENSLEY AIR FIELD (NBE) FORECAST GUIDE

1. UNITS SUPPORTED: (Dallas Navy Air Station)

2. PHYSICAL DESCRIPTION AND LOCATION: Hensley Field is located 10 miles west of downtown Dallas but east of Fort Worth. The area is urbanized except for Mountain Creek Reservoir south of the field. Carswell Air Force Base, whose Forecast Guide will be used for this station, is 20 miles west on the other side of Fort Worth. Field elevation is 815 feet, and the runway is oriented 17-35.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Hensley is north of Mountain Creek Reservoir which is a potential source of fog with light moist southerly flow. This is in some contrast to Carswell which is south of a smaller expanse of water and is less susceptible to advection-radiation fog. The effect of the hills near Mineral Wells is much less noticeable at NBE than at FWH. Urban pollution should lower the visibility about as much as it does at Carswell.

4. SYNOPTIC TYPES AND FORECAST RULES: See Section 4 of Carswell Forecast Guide.

5. SEASONAL FORECAST RULES: See Carswell Forecast Guide.

SHEPPARD 3
ARDMORE
SPRINGER
Tishomingo
Healdton
Ringling
Wilson
Waurika
Madill
Bokchito
HE
JE
KE
34°
LAKE TEXOMA
DURAN
Nocona
Saint Jo
Bowie
GAINESVILLE
DENISON
GRAYSON
Van Alstyne
Leonard
Ladonia
Honey Grove
DENTON
BRIDGEPORT
Decatur
Bridgeport
Sanger
GARZA
LITTLE ELM RESERVOIR
Celina
McKinney
Farmersville
Ponder
ADDISON
Wylie
97°
96°
HD
JD
KD
33°
CARSWELL
DALLAS LOVE
FORT WORTH
DALLAS
ARLINGTON
NAVY DALLAS
LANCASTER
WAXAHACHIE
SCURRY
ACTON
Alvarado
Glen Rose
LAKE TAWAKONI
Kaufman
Trinity River
MILLSAP
HC
JC
KC

FORT HOOD - GRAY AAF (GRK) FORECAST GUIDE

1. UNITS SUPPORTED: III Corps Hq., Ft. Hood and Subordinate units. Principle amendment criteria are 300 and/or 3/4 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Fort Hood lies in East Central Texas 120 miles north-northeast of San Antonio and 130 miles south-southwest of Dallas. The Gulf of Mexico is 200 miles southeast at its nearest point. Fort Hood is on the east side of the Texas "Hill Country" at an elevation higher than the surroundings. The land continues to rise to the west. Field elevation is 923 feet, and the runway is oriented 15-33.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Moving to GRK from the southeast, the gradual rise in elevation from the Gulf of Mexico steepens just southeast of Fort Hood, so stratus is at least as frequent and persistent as anywhere else in east central Texas. Some of the local hills are nearly 1,000 feet higher than the airfield. A depression east of the airfield occasionally fills with radiation fog which drifts over the field at sunrise in any weak southeast flow. Air mass thunderstorms occur on some afternoons during the summer. There are no significant local pollution sources other than springtime dust storms from the west.

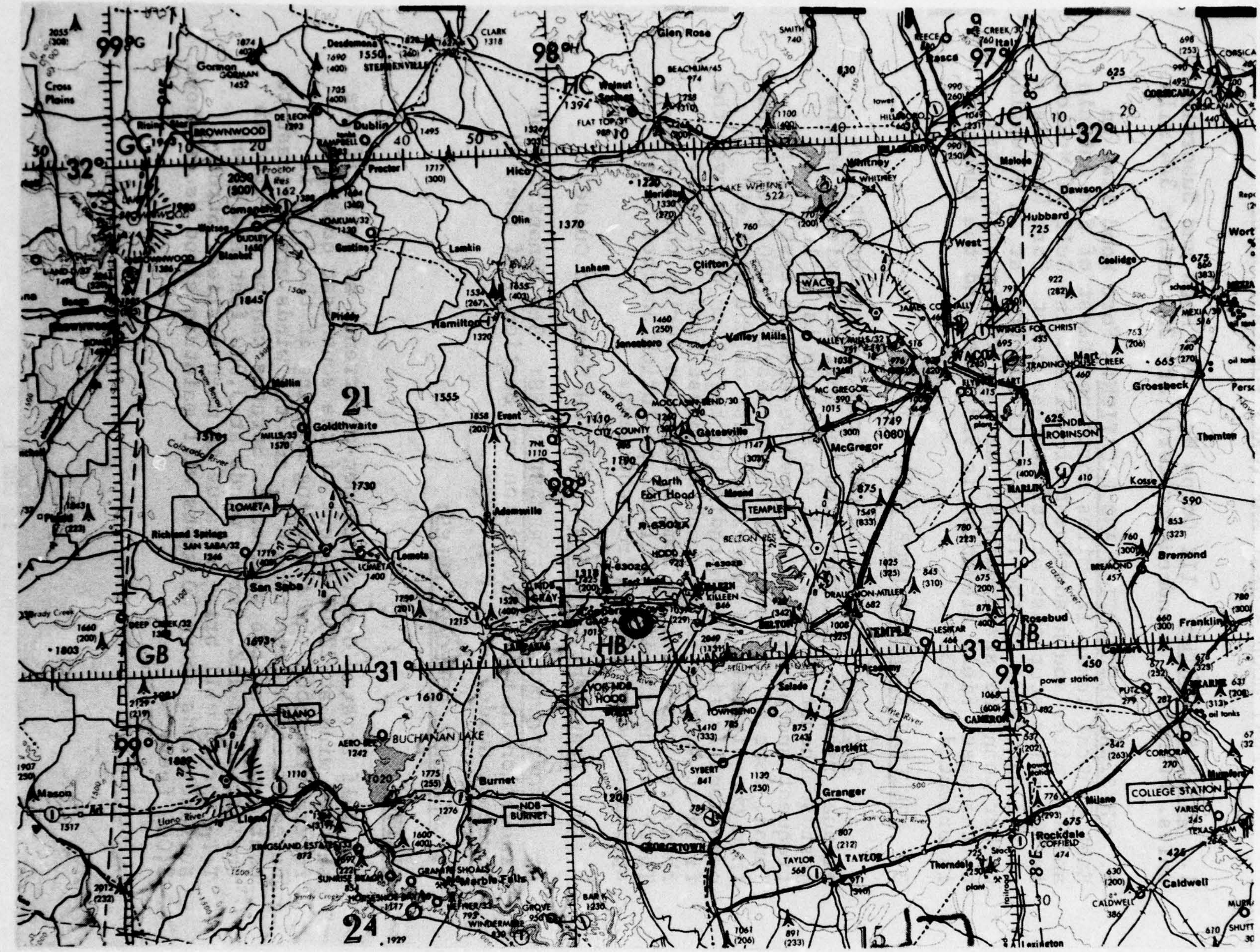
b. Transient Controls: See FWH Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the FWH Forecast Guide.

5. SEASONAL FORECAST RULES:

WINTER

a. Gulf stratus occurrence/non-occurrence at Gray: If the surface wind at 2200Z is out of the southeast quadrant, forecast stratus the following morning if the $T-T_d$ is forecast to be less than $6^{o}F$, and the winds are forecast to continue out of the southeast. Stratus can be expected in the period 10-16Z. Strong winds at 3,000 feet and lower $T-T_d$ spread will bring stratus in much earlier. Strong surface winds above 20 knots will maintain cloud bases above 2,000 feet.


BROWNWOOD
WACO
ROBINSON
TEMPLE
LOMETA
LLANO
COLLEGE STATION
BUCHANAN LAKE
Goldthwaite
Hamilton
Gatesville
McGregor
San Saba
Burnet
Georgetown
Taylor
Granger
Bartlett
Cameron
Rockdale
Caldwell
Bremond
Franklin
Kosse
Groesbeck
Hubbard
Dawson
Hico
Dublin
Comanche
Clifton
Valley Mills
Lampasas
Killeen
Belton
Salado
Marlin
Mart
Mason
Llano
Marble Falls
Stephenville
Glen Rose
Whitney
Lake Whitney
Corsicana
Brazos River
Colorado River
Llano River
Leon River

b. Forecasting post-frontal stratus at Gray: Generally, forecast ceilings between 600 and 1,500 feet between the 700 mb trough and surface front; ceilings of 1,500 feet or higher between the 700 mb trough to the 850 mb isotherm trough; no low ceilings west of the 850 mb isotherm trough. Ceilings under isotherm ribbons will be 300 to 500 feet or lower depending on cyclonic curvature or the proximity of the surface closed low.

ALL SEASONS:

a. Forecasting gusty surface winds in excess of 25 knots at Gray: Surface winds can be approximated as an average of the winds at and below 850 mb with peak winds approximately one-third of the average. When a representative sounding is not available, the 850 mb or 5,000 foot level wind may be used. The figures opposite the 850 mb level winds will approximate the surface winds. Heating has to be forecast great enough to break the low-level inversion. (Rule works best in summer and early fall).

* 850 mb Wind	Surface wind
20	11-23
25	12-20
30	14-28
35	15-31
40	16-33
45	18-36

* Off sounding or estimated.

BERGSTROM AFB (BSM) FORECAST GUIDE

1. UNITS SUPPORTED: 67th TRW (3 RF-4C Sqs), 602nd TACG (OV-10 Sq, O-2 Sq), 67th CSG/OT (T-33), Det 3 , 1400 MAW (T-39). Exception amendment criteria are 1500, 500 and 100 feet; 1½, 1, 3/4, and ¼ mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Located 6.5 miles southeast of Austin, Texas, Bergstrom Air Force Base is situated in the broad Colorado River Valley. To the west of the base is a line of hills that are a result of the Balcones Fault. The Colorado River Valley merges with the caostal plain which slopes gradually to the southeast down to the Gulf of Mexico. As a result, the slope contributes significantly to one of Berstrom's major forecasting problems - stratus. Rounded hills, some of which extend two hundred feet above the base, surround Bergstrom from the south clockwise to the north. This hilly country begins on a north-south line through Austin and rises sharply ten miles northwest of the base where Mt. Baker and Mt. Bonnel reach to approximately 800 feet above mean sea level. The field elevation itself is 541 feet, and the dual runways are oriented 17-35. The Colorado River winds to within two miles of the northeast side of the base. It can provide an additional moisture source.

3. PECULIAR FORECAST PROBLEMS:

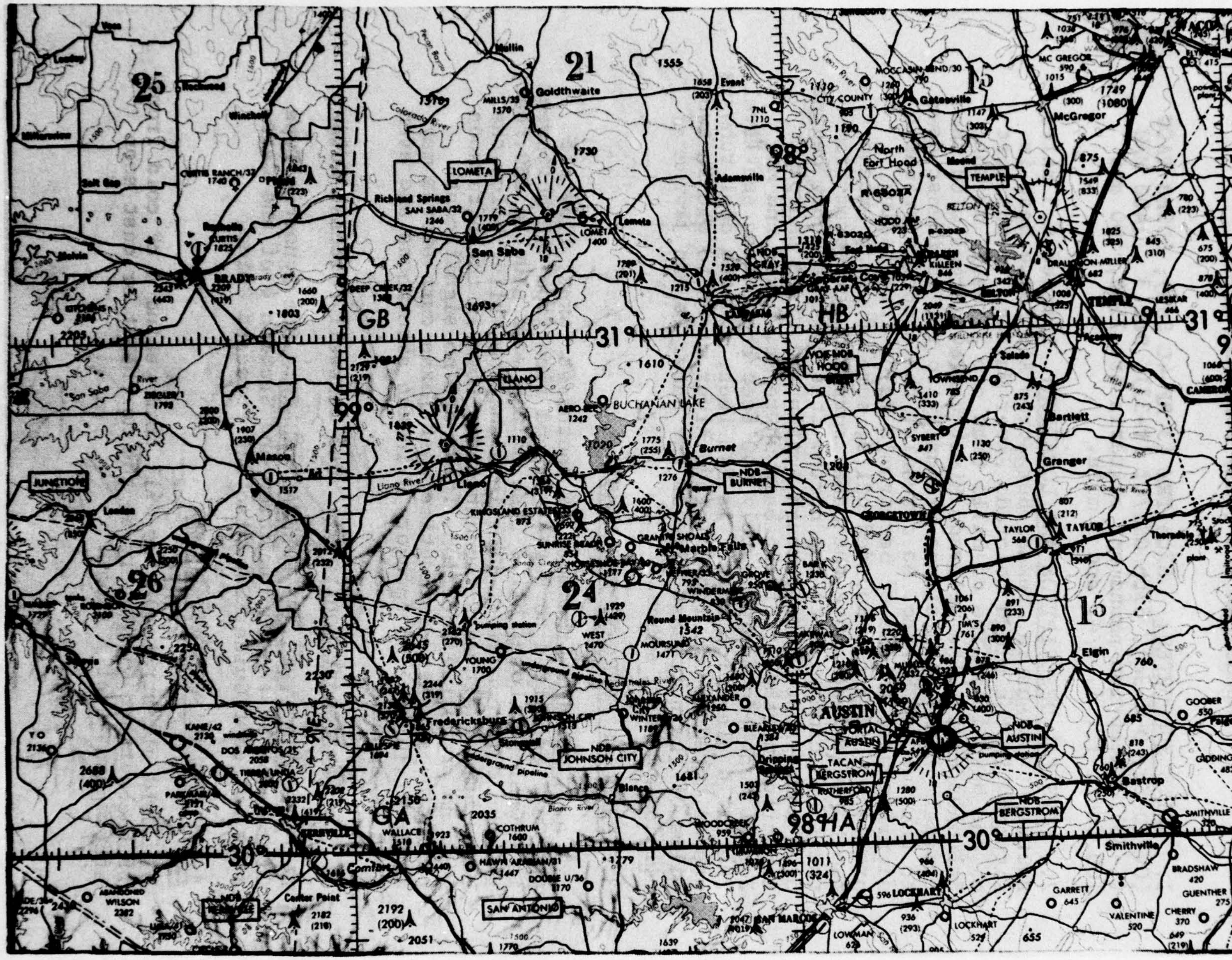
a. Terrain: Like most of southeast Texas, flow off the Gulf is lifted to Bergstrom,and flow from the northwest is downslope. Local hills rise on the west side to 200 feet, and the Colorado River lies in a shallow valley below the base. Summer air mass thunderstorms form in the afternoon with no preferred location. There are no significant pollution sources. Springtime west Texas dust storms may lower visibility to category D in the afternoons and even to C at sunset.

b. Transient Controls: See Carswell Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Carswell Forecast Guide. See also SKF Forecast Guide.

5. SEASONAL FORECAST RULES:

a. Cold air stratocumulus will form behind a cP cold front if the surface wind veers to the northeast or east soon after passage of a front.


Goldthwaite
LOMETA
Richland Springs
San Saba
Lometa
Gatesville
North Fort Hood
McGregor
TEMPLE
BRADY
GB
HB
LLANO
BUCHANAN LAKE
Burnet
NDB BURNET
JUNCTION
Mason
Llano River
Salado
Bartlett
Granger
GEORGETOWN
TAYLOR
KINGSLAND ESTATES
GRANITE SHOALS
Marble Falls
SUNRISE BEACH
Round Mountain
Fredericksburg
NDB JOHNSON CITY
Blanco
AUSTIN
TACAN BERGSTROM
NDB BERGSTROM
NDB AUSTIN
Elgin
Bastrop
Smithville
GIDDINGS
GOOBER
GA
98 HA
COTHRUM
SAN ANTONIO
LOCKHART
Center Point
BRADSHAW
GUENTHER
CHERRY
VALENTINE
GARRETT

b. 12-24 hours after a cP frontal passage in winter and a 500 mb low over southern California present, expect extended periods (24-72 hours) of low ceilings, poor visibility and light rain or drizzle.

c. In summer, the first night after return of southerly flow and after 80 to 100 knot hours of such flow, forecast Gulf stratus to form after midnight.

d. Squall-line thunderstorm activity is most often associated with mP_k fronts especially during spring (Mar-June).

e. The southern end of springtime squall-lines that form near San Angelo associated with mP_k fronts rarely reach BSM unless the winds between 10,000 and 20,000 feet are north of 250°.

f. Severe weather associated with squall-lines approaching BSM from the northwest will lose intensity just prior to reaching the base. It will re-intensify as it moves east of the base.

KELLY AFB (SKF) FORECAST GUIDE

1. UNITS SUPPORTED: San Antonio Air Logistics Center, Lackland Military Training Center, 1923rd Communications Group, 433rd TAW (AFRES), 149th TFG (ANG), Det 5, 375th AAW. Exception amendment criterion is 1500 feet.

2. PHYSICAL DESCRIPTION AND LOCATION: Kelly Air Force Base is located in southwest San Antonio, a city of some 700,000 people. The base lies in an urban setting with local scrubland and low hills to the northwest. The sole moisture source is the Gulf of Mexico which is 125 miles east-southeast at the closest point. Land further west and northwest is up to 2,500 feet higher so that flow from these directions is dry and downsloping. The field elevation is 690 feet, and the runways are oriented 15-33 and 14-32.

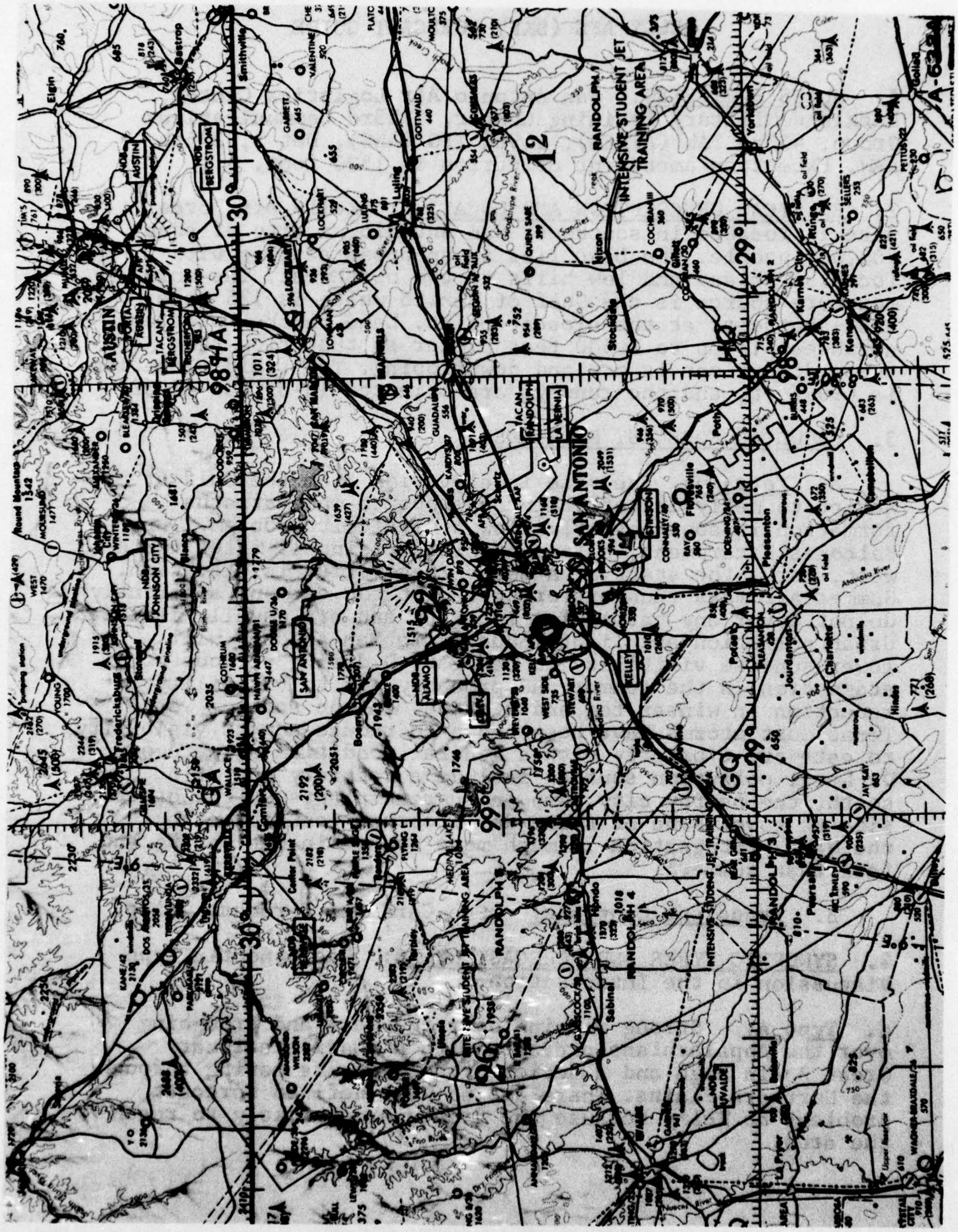
3. PECULIAR FORECAST PROBLEMS:

A. Terrain: The rise in elevation from the Gulf of Mexico to Kelly is sufficient upslope to make stratus formation in southeasterly flow a difficult problem. The Balcones Escarpment, a line of hills rising 15 miles northwest, marks the start of a much greater rise in elevation. Summer air mass thunderstorms are not too common, apparently do not favor any particular locality and are usually isolated. Urban pollution and light industry in San Antonio will lower sunrise visibility to category D during periods of stagnation in the summer and probably add to visibility reduction in winter fog and stratus. In the spring, west Texas dust storms have been known to reduce sunset visibility to category C briefly with a general condition of cetegory D. Local pollution sources include a refinery one mile south, the nearby city dump and cement plants on the other side of town. None of these do more than contribute to the haze. (Stagnation is much more common in the spring and fall than summer).

B. Transient Controls: See Carswell Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Strong ridging over the West and troughing over the Appalachians prevails with a quasi-stationary Great Basin High and a series of cold fronts moving through the Northern Plains. There are no well-defined forecast problems at Kelly because the fronts are unlikely to reach the area.


SAN ANTONIO
AUSTIN
RANDOLPH 1
RANDOLPH 3
RANDOLPH 4
RANDOLPH 8
INTENSIVE STUDENT JET TRAINING AREA
KELLEY
STINSON
LA VERNIA
TACAN RANDOLPH
NDB JOHNSON CITY
NDB BERGSTROM
TACAN BERGSTROM
NDB AUSTIN
NDB ALAMO
NDB UVALDE
Fredericksburg
Pleasanton
Jourdanton
Charlotte
Poteet
Floresville
Stockdale
Nixon
Smithville
Bastrop
Elgin
Lockhart
Luling
Seguin
New Braunfels
Boerne
Hondo
Sabinal
Uvalde
Yorktown
Kenedy
Karnes City
Goliad

b. Type B: This type differs from Type A in that the Great Basin High is active and follows weak cold fronts through the Kelly area.

(1) Fast-Moving Cold Front: In this situation, cold fronts from the northwest are preceded by south-southeast flow to 30 knots in the afternoon. Most fronts are dry, although a narrow band of category D stratocumulus may appear. Pre-frontal squall-lines are unlikely. Post-frontal winds are northwesterly and may gust to 30 knots (consider category D dust) during late afternoon. These fronts are most likely in the fall.

(2) Stagnant High: A slow-moving high may follow the surface front through and then stall in the southern Mississippi Valley. Isolated afternoon showers with patchy category D stratocumulus and/or B stratus in the morning. Near the center of the high, category D visibility in haze may occur. Once the high reaches the mid-Gulf states, return flow may draw in Gulf stratus. Again, category B clouds are most likely late at night or in the morning.

c. Type C: A large upper low over the southwest U.S. moves little. West-southwesterly flow aloft may be strong with extensive high cloudiness embedded.

(1) Southwest flow over Warm Surface Air: Early and late in the season, surface temperatures may be quite warm. With this type, a quasi-stationary front usually lies across Oklahoma or Kansas, so that southeast Texas is in southerly flow. Heavy high clouds remain category E, and isolated showers may develop in the afternoon. Surface winds may be south-southeast at 25 knots.

(2) Southwest Flow over Cold Surface air: Winds will be northerly and gust to 25 knots for about 24 hours following. A wave will normally form along the front southwest of Kelly advecting category A and possibly B or C ceiling and visibility until the wave passes the Kelly longitude. This southward movement of the front is somewhat unusual for this synoptic type.

d. Type D: This low develops in eastern Colorado and crosses the Central Plains well to the north. Southerly inflow and a following arctic outbreak after cold front passage are typical.

(1) Southerly flow into Low: Gusty winds and moisture inflow off the Gulf occur as pressures fall in the lee of the Rockies. The associated stratus is category B and quite persistent in mid-winter. Late in the season, category C is more likely for the period mid-morning to early evening. Surface winds may be south-southeast at 25 knots in the afternoon. Visibility reduction in such flow is at

worst category D during late night and early morning. Late in the winter season or in the spring, skies may clear in the afternoon.

(2) Polar outbreak: Conditions resemble the overruning case of Type C, but the weather largely depends on the strength of the front. If the outbreak pushes the front way out into the Gulf, stratus will form behind the front in B or low C category with D category visibility in drizzle. The ceilings will last 6-12 hours, then break up to C category and remain for 6 more. Northerly winds are 25 knots. If the front stalls in the Gulf or across southern Texas, expect the return of category B stratus especially if a weak wave forms on the front. (See also Type E). When the high following the front moves into the central Gulf states, return flow will draw category B stratus in by 18-24 hours.

e. Type E: These lows develop anywhere from the Panhandle southeast to the western Gulf. All fronts and sectors of the developing wave must be considered.

(1) Gulf Low: Southeast Texas experiences northeast flow, light rain and category B stratus as the wave develops and remain until the wave moves into Louisiana. These systems often develop of stalled fronts in extreme southern Texas. Winds may gust up to 30 knots with thunderstorms around the top of the wave.

(2) Panhandle Low: These lows more closely resemble Colorado Lows with a more southerly track. Location of development extends from the New Mexico border to western Arkansas. The warm front portion of the wave usually becomes apparent north of SKF but if not expect category B stratus and fog with gusty southeasterly winds and moderate precipitation. Conditions improve rapidly as the front passes and moves on to the northeast. In the warm sector, gradient winds may be strong out of the south or southwest to 35 knots. Clouds are patchy, but some category C stratus may form during the night. The main problem centers on the development of instability lines in the afternoon stirring up some very severe weather. The instability line precedes the cold front by a few hours, and in mid-winter a moderate polar outbreak will occur. Northwest winds behind the front will gust up to 35 knots. Visibility can also be reduced in blowing dust during the late afternoon. Some category D stratocumulus will accompany the cold front with raid clearing thereafter.

SUMMER

a. Type B: Southeast flow off the Gulf prevails, but air mass thunderstorms are isolated and only then in the afternoon. Brief category D cumulus ceilings may develop late in the morning. Stratus incursions are infrequent usually occurring early in the season at night when the Marfa Front is in existence. Tropical activity in the Gulf usually increases air mass activity further inland. More substantial category D ceilings and rain may occur late in the season with easterly waves and tropical disturbances.

b. Type E: This middle and late season pattern is typical of those occasions when the Bermuda High moves out into the Atlantic. Slow-moving cold fronts will move into Texas setting off numerous afternoon and evening showers and thundershowers.

5. SEASONAL FORECAST RULES: See Carswell Forecast Guide and add:

WINTER

a. In winter and spring, forecast redevelopment and movement of quasi-stationary cold fronts north of Kelly if the 500 mb height rises north of Montana are 80 meters or more in 12 hours.

b. In winter and spring, forecast stratus the night following the passage of a high center across the Mississippi River north of 32°N. Forecast fog if the center passes southwest of Kelly.

SUMMER

a. In the spring and summer (situation favorable for stratus formation) if the low-level jet is east of Kelly, forecast scattered Gulf stratus coverage; jet overhead - broken coverage; jet west - overcast coverage.

b. During spring and summer, forecast no stratus on the first night of return flow.

c. In summer, with maximum temperature in excess of 100°F, forecast no stratus the following morning. (If the temperature is over 90°F over a wide area, stratus the next morning will be spotty and very difficult to verify as broken).

d. In the summer, forecast no hail and no winds in excess of 34 knots in air mass thunderstorms moving from the south and east toward Kelly.

e. In summer with 14,000 foot winds from the south through southeast at 15 knots or greater, forecast presence of thunderstorms in the Kelly vicinity by 1600L if they occur on the Texas Gulf coast during the morning hours.

f. In spring through fall, forecast heavy rainshowers and local flooding if an active easterly wave coincides with a long wave trough over south central Texas.

g. With temperatures of 90°F or more, it is unfavorable to forecast stratus over Kelly the following morning during fall, winter and spring.

h. In winter and spring, forecast clearing over Kelly 6 hours after Laredo and/or Del Rio clear from the same conditions, and clearing from the west is apparent.

RANDOLPH AFB (RND) FORECAST GUIDE

1. UNITS SUPPORTED: 12 FTW, 1400 MAS and 5th Army Flight Detachment. Additional amendment criteria are 1500 feet, 300 feet and one mile. Flight training functions have other important criteria such as icing of any intensity, hail of any size and other normal weather warning parameters.

2. PHYSICAL DESCRIPTION AND LOCATION: Randolph Air Force Base is located 15 miles northeast of San Antonio. The base lies on scrub land with moderate urbanization, and the Gulf of Mexico is 110 miles east-southeast at its closest point. Field elevation is 761 feet, and the runways are oriented 14-32.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Randolph is less affected than Kelly by urban pollution since the prevailing flow is from the southeast. Reduced visibility is slightly less likely. Otherwise, the terrain effects are the same at Randolph as Kelly.

b. Transient Controls: See Carswell Forecast Guide. There are important exceptions. The same systems affect RND as FWH, but RND is at a much lower latitude and is considerably closer to the Gulf of Mexico. The systems tend to be less intense, and moisture at low levels greatly increased in the mean with higher subsequent rainfall. In addition, hail occurrence is much less likely with a higher wet-bulb zero and increased intensity of systems.

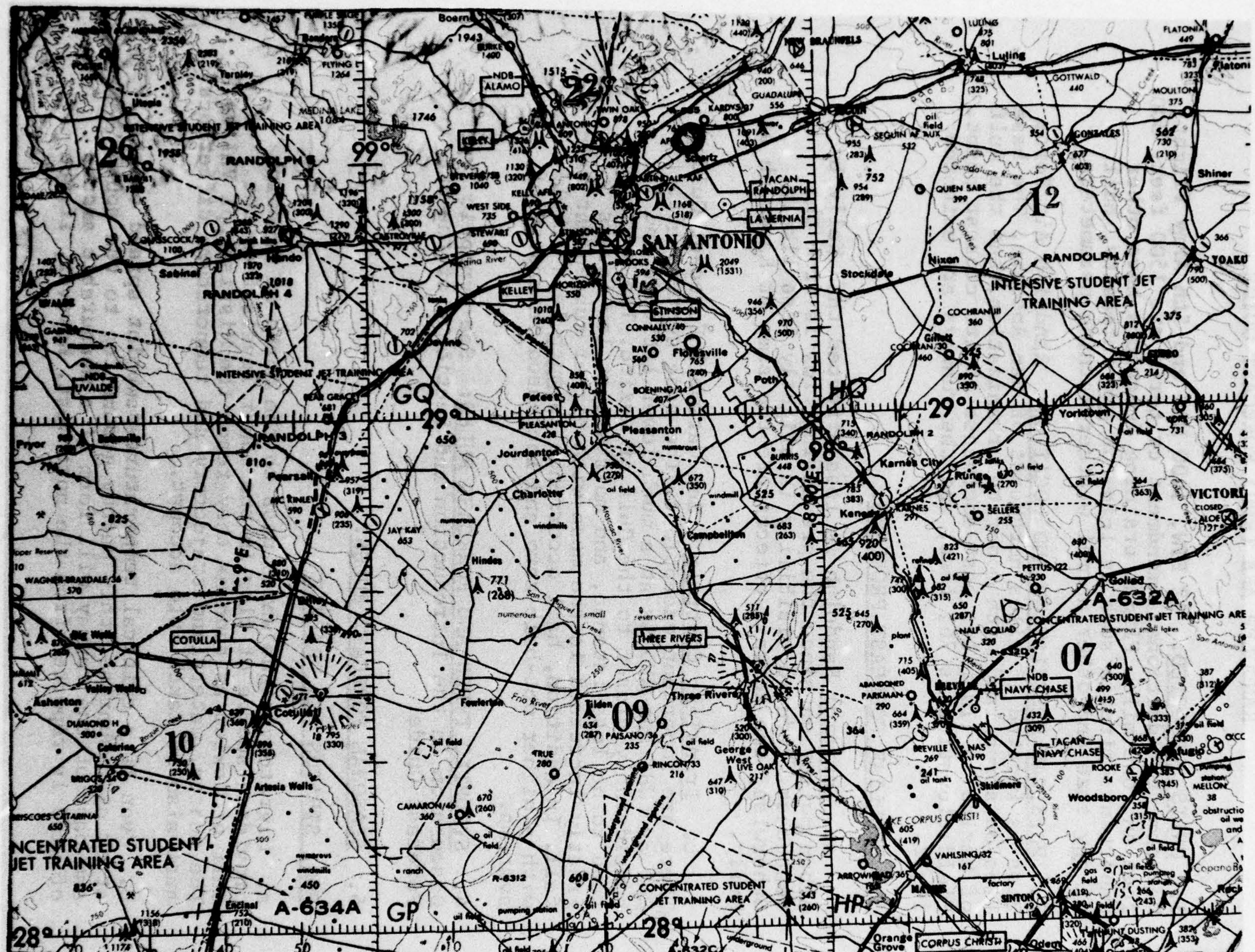
4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the SKF Forecast Guide.

5. SEASONAL FORECAST RULES:

FOG, STRATUS AND DRIZZLE

a. Migratory highs which pass to the north of Randolph provide a source of flow in the lower levels from the Gulf of Mexico as soon as they reach the Mississippi Valley. The season, water/land trajectory and temperature difference must also be taken into account.

b. Even if a critical temperature-dewpoint spread exists at or near sunrise, only patchy ground fog to the south and east of the runway will form if a measurable amount of wind is reported from the northwest. However, if the


SAN ANTONIO
INTENSIVE STUDENT JET TRAINING AREA
CONCENTRATED STUDENT JET TRAINING AREA
RANDOLPH 1
RANDOLPH 2
RANDOLPH 3
RANDOLPH 4
A-632A
A-634A
A-632C
R-6312
KELLEY
STINSON
RANDOLPH
LA VERNIA
ALAMO
UVALDE
COTULLA
THREE RIVERS
NAVY CHASE
CORPUS CHRISTI
VICTORIA
Boerne
Luling
Gonzales
Shiner
Yoakum
Nixon
Stockdale
Floresville
Pleasanton
Jourdanton
Charlotte
Karnes City
Kenedy
Yorktown
Goliad
Hindes
Three Rivers
George West
Tilden
Fowlerton
Cotulla
Pearsall
Hondo
Sabinal
Asherton
Artesia Wells
Encinal
Beeville
Skidmore
Woodsboro
Sinton
Odem
Orange Grove
Mathis
99°
98°
29°
28°

winds are light and variable or calm, patchy ground fog will form to the east and south of the runway with as much as a 5 degree $T\text{-}T_d$ spread.

c. In the summer, significant surface pressure rises following passage of an easterly wave over south Texas normally produce an increase in nocturnal stratus.

d. 24-48 hours prior to passage of a significant easterly wave in summer over south Texas, the weather is usually characterized by extensive subsidence, nocturnal stratus and daytime cumulus.

e. During the spring and summer months, formation of stratus seldom takes place until the second or third night of return flow. In winter, a long over the water trajectory will bring the stratus in much faster.

f. Drizzle of an appreciable amount should usually be forecast at Randolph when strong southerly winds in middle levels (2,000 to 10,000 feet) are prevalent with a stratus overcast. Horizontal convergence of winds enhance the possibility of drizzle. The first return of tropical air (63° dewpoint), mixing with polar air and warm front effects also add to the probability.

g. Under south-southwesterly winds, much lower visibility and denser fog conditions occur at Randolph than at San Antonio. Usually stratus ceilings are lower at Randolph than San Antonio because of upslope terrain and elevation difference.

WINDS:

a. Low level southeasterly winds (1,000 to 3,000 feet) at Randolph usually veer 20-30 degrees from 2100-0300L and back 20-30 degrees from 0900-1500L. This applies mainly to wind speeds of 10 knots or less.

FRONTS AND WAVES:

a. With a slow-moving and shallow cold front passing Brownsville (weak 5-10 knot northerly winds on the surface) and the trough aloft hanging far to the northwest, ceilings will lower to around 500 feet at RND and take about six hours to improve to 1,000 feet especially when the front passes around daybreak. Slower improvement can be expected when the front passes Brownsville at night. This is usually accompanied by drizzle and visibilities lowering to 1-3 miles for the first three hours.

b. In winter and spring when any significant frontal discontinuity lies in the district and a sharp 500 mb trough reaches the California-Arizona border, forecast a wave forming in south Texas within 12 hours. If the front lies in the Gulf of Mexico, forecast the wave in the vicinity of the intersection of the front with the Texas or Mexican coast. (Type E, E_s).

c. In the spring with a series of weak waves moving eastward usually along a quasi-stationary front through northern Texas and/or Oklahoma, a weak trough will form around a dewpoint discontinuity west of Randolph. The trough moves east of Randolph during the day and back to the west at night as another wave forms in the Panhandle. There will be low ceilings and fog in high dewpoints 50-100 miles east of the trough with rapid clearing on the west side. The trough usually does not reach the coast or move very far to the west of Randolph. (Type C).

d. In the spring with a trough in west Texas and the warm front moving northward through central Texas, a weak low may be detected by 1 mb analysis near the intersection of the warm front and trough. Thunderstorms quickly develop in the low area with possible tornadoes on the north side. The low and accompanying thunderstorms will move rapidly eastward. (Type E).

e. In the winter and spring with an arctic front quasi-stationary anywhere from northern Texas to Nebraska, large rises at 500 mb developing in the vicinity of Montana northward into Canada indicate that rapid southward movement of the front will soon begin with the front continuing to move rapidly into the Gulf of Mexico. A strong isotherm packing should exist at the 850 mb level with a strong 30 knot wind flow perpendicular to the packing. (Type C pattern which is breaking down into a Type E).

f. When an active wave is off the Texas coast and large pressure falls develop in southern Louisiana with gusty east surface winds at Galveston and Beaumont, forecast rapid northeast movement of the wave with possible thunderstorms in southeast Texas and rapid clearing (12-24 hours) moving into south central Texas from the west. (Type E).

g. Winter warm fronts generally do not move faster than 10-15 knots northward through south Texas. They do, however, frequently stall south of the station causing ceiling and visibility problems. (Any type where cold front returns as a warm boundary).

h. Gusty northwest through north winds should continue for 18-24 hours following the passage of a sharp cold front

at San Antonio to insure continued southward movement out of the area. Diminishing winds in less time usually indicate complications such as wave action or the front becoming stationary along the warm coastal waters. This rule applies to surface winds at San Antonio only.

i. Expect heavy rains with some flooding probable when a full latitude westerly trough arrives over central Texas coincidental with an active easterly wave from the Gulf of Mexico. This situation is most common in September.

j. Most easterly waves average 5 degrees longitude movement per 24 hours. Deceleration indicates development, acceleration indicates weakening.

k. The most common location for development of a closed low in the vicinity of an easterly wave in the western Gulf of Mexico is 5 degrees longitude east of the major low level wind shift (surface to 10,000 feet).

NORTHWEST-NORTH FLOW AND CALM CONDITIONS

a. Restriction to visibility of less than 6 miles should not be forecast with these flow conditions (possible exception - 6% chance of visibility being reduced as low as 3 miles between 0700-0900L).

b. Usually the stratus will form late, after 0400L and be scattered by 0800L. The stratus can form, however, as early as 0100L, and there is a 12% chance that it may remain as late as 1300L. CC tables will forecast the stratus to be scattered by 1000L.

c. Stratus ceilings will usually be between 1,000 and 3,000 feet. There is less than a 10% chance of occurrence of ceilings below 1000 feet but above 500 feet, and a 0% chance of the stratus ceilings being below 500 feet.

LAUGHLIN AFB (DLF) FORECAST GUIDE

1. UNITS SUPPORTED: 47th FTW (T-37, T-38). Ceiling/visibility at or above 300 feet and/or 1 mile allow aircraft to take off provided they have suitable alternate. Light icing conditions prevent T-38 from flying. Greater than light icing grounds both types of aircraft.

2. PHYSICAL DESCRIPTION AND LOCATION: Laughlin Air Force Base is located in the Rio Grande Valley at the Texas-Mexico Border, 6 miles east of Del Rio. The general climate is hot and arid when compared to much of southwest Texas. The Gulf of Mexico is 225 miles southeast at its closest point. Field elevation is 1081 feet, and the primary instrument runway is 13-31.

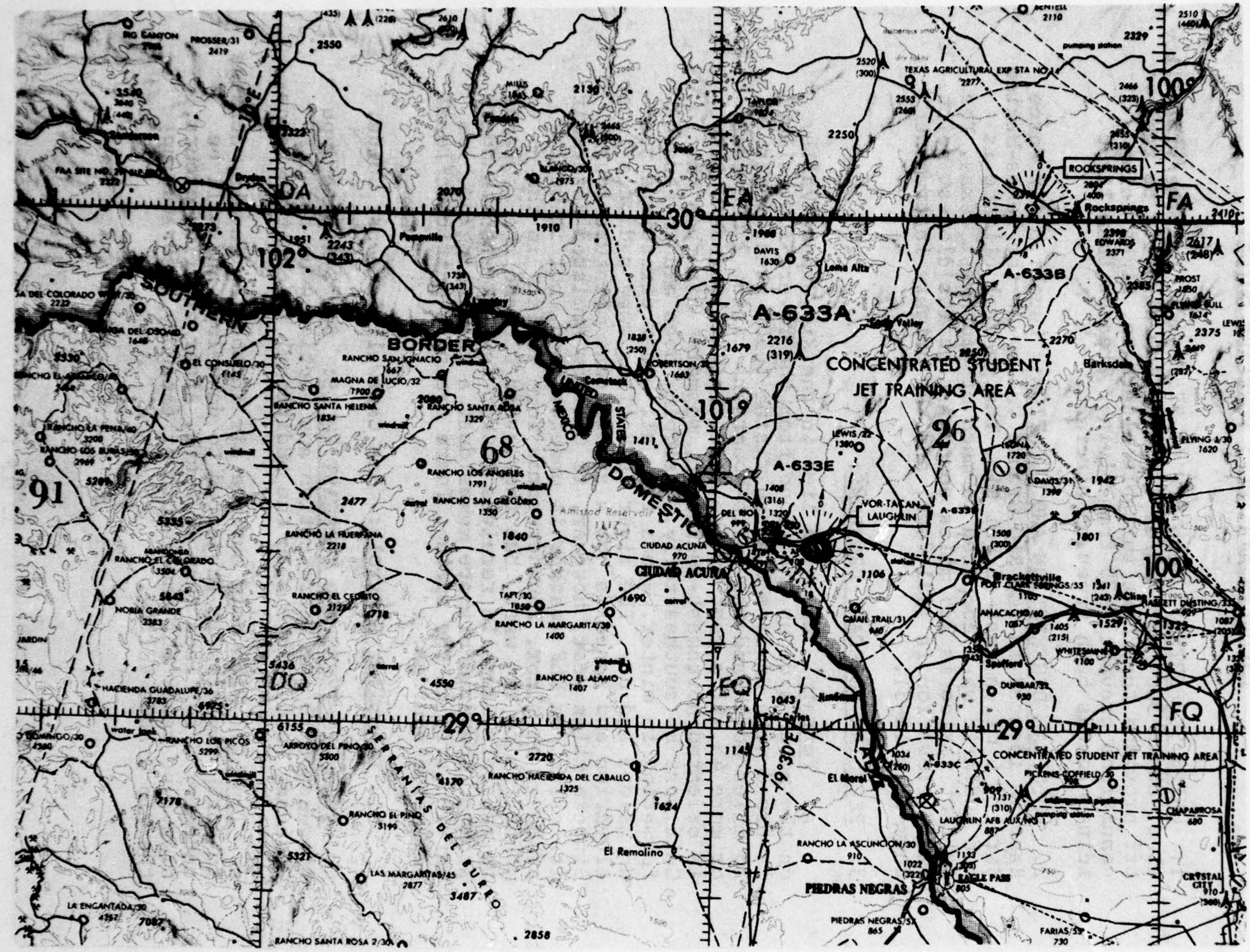
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Laughlin lies in the Rio Grande Valley on the north side up the slope from the river. The valley is broad with Edwards Plateau rising 1,500 feet higher 25 miles north and the Burro Mountains rising 2,000 feet or more 45 miles west of the base. The Rio Grande Valley is oriented northwest-southeast, so moist air from the Gulf must be southeasterly. Upsloping does aid in stratus formation in winter. Winds from all other directions are downslope and dry. The river is 8 miles away and at a lower elevation and hence is not a significant moisture source. Sixteen miles west, however, is the new Armistad Reservoir. Its effect on DLF weather is undetermined, but it will probably be minor. Thunderstorms form rapidly in the mountains to the west, but they avoid DLF and the lowlands in general. Laughlin receives rather few air mass thunderstorms. The arid climate makes dust a continuing problem particularly in the spring. There are no significant local pollution sources.

b. Transient Controls: See Carswell Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the SKF Forecast Guide. Note also the additional information below.

a. Type C: With cold surface air in the low levels, stratus in northerly flow is subjected to downslope and will be category C for less than 48 hours. After clearing occurs, always be ready for the return of category B stratus up the Rio Grande Valley.



CONCENTRATED STUDENT
JET TRAINING AREA
A-633A
A-633B
A-633E
A-633C
VOR-TACAN
LAUGHLIN
ROCKSPRINGS
Rocksprings
BORDER
DOMESTIC
SOUTHERN
UNITED STATES
MEXICO
CIUDAD ACUNA
DEL RIO
Brackettville
PIEDRAS NEGRAS
EAGLE PASS
LAUGHLIN AFB AUX NO 1
SERRANIAS DEL BURRO
TEXAS AGRICULTURAL EXP STA NO 1
RANCHO LOS ANGELES
RANCHO SAN GREGORIO
RANCHO LA MARGARITA/30
RANCHO EL ALAMO
RANCHO HACIENDA DEL CABALLO
RANCHO EL PINO
RANCHO LA ASCUNCION/30
HACIENDA GUADALUPE/36
NORIA GRANDE
El Remolino
Amistad Reservoir
CONCENTRATED STUDENT JET TRAINING AREA
30°
29°
102°
101°
100°

b. Type E: These lows sometimes may begin in northern Mexico or else develop in the Gulf. In the former case, expect category B stratus with intermittent light precipitation and northeast winds to 25 knots until the low moves into the Gulf. Gulf lows bring patchy stratus, north winds and category D middle clouds. Skies clear as low moves eastward.

5. SEASONAL FORECAST RULES:

WINTER

a. Downslope stratus from the north is category C, but upslope stratus from the Gulf is category B.

b. Northwesterly winds tend to be 10 knots weaker at DLF than over other portions of west or central Texas.

c. Stratus moves in readily in southeast flow and should break up in the afternoon if the deck is about 1,200 feet or less. If it breaks up at dawn, expect it to return by mid-morning.

SUMMER

a. Frequent air mass thunderstorms form 50 miles to the west but do not move in unless a trough on the dry line (Marfa Front) moves through DLF. This tends to occur after sunset. Winds gusts may well exceed 35 knots.

b. Air mass thunderstorms also develop southeast-southwest of DLF and move slowly northward during the summer. These thunderstorms are of a tropical nature and usually dissipate by sunset.

ALL SEASONS:

a. Stratus clouds will form or advect to DLF when the low level winds (surface-4000 feet) are moderate southeasterly (15-20 knots), and upstream stations (VCT, BRO) also have a southeasterly wind direction. In late spring or early fall, the stratus will form as late as 0900L and will persist for only a few hours. The bases of the stratus are usually above 1,000 feet with bases more common at 1,500 feet (+/- 300 feet) with tops at 2,500-3,000 feet.

b. During late fall to early spring, stratus ceilings will advect to DLF as early as sunset and persist to mid-afternoon. The bases of the stratus will be near 1,000 feet and decrease

to as low as 300 to 500 feet by mid-morning with reduced visibility due to drizzle; tops of the stratus are 5,000 to 6,000 feet.

c. The scattering of the stratus ceiling can accurately be forecasted by the use of the Del Rio Skew-T. With slightly stronger low level southeasterly winds (20-30 knots), a stratus ceiling will persist 2-4 hours longer than the indicated time of scattering by the skew-T.

d. The prevailing wind direction is southeasterly at DLF except after frontal passages or troughs; then the direction will almost always be from the northwest. Forecast wind speeds by using 75% of the 2-3,000 foot winds or by using the sea level pressure difference between DRT and SAT; 1 knot for every 0.1 mb difference between the two stations. This rule works fairly well except when the DRT sea level pressure is higher than SAT.

e. To forecast the maximum wind gust with a fine line passage, determine the speed of the line and then add 20%.

f. The 500 mb wind, if in excess of 20 knots, will usually always give some movement to the thunderstorms that form in old Mexico. 30 knots plus will cause a definite movement.

g. Never forecast southwest winds of over 10 knots unless with a thunderstorm.

ELLINGTON AFB (EFD) FORECAST GUIDE

1. UNITS SUPPORTED: TAW (C-130), TANG (F-102).

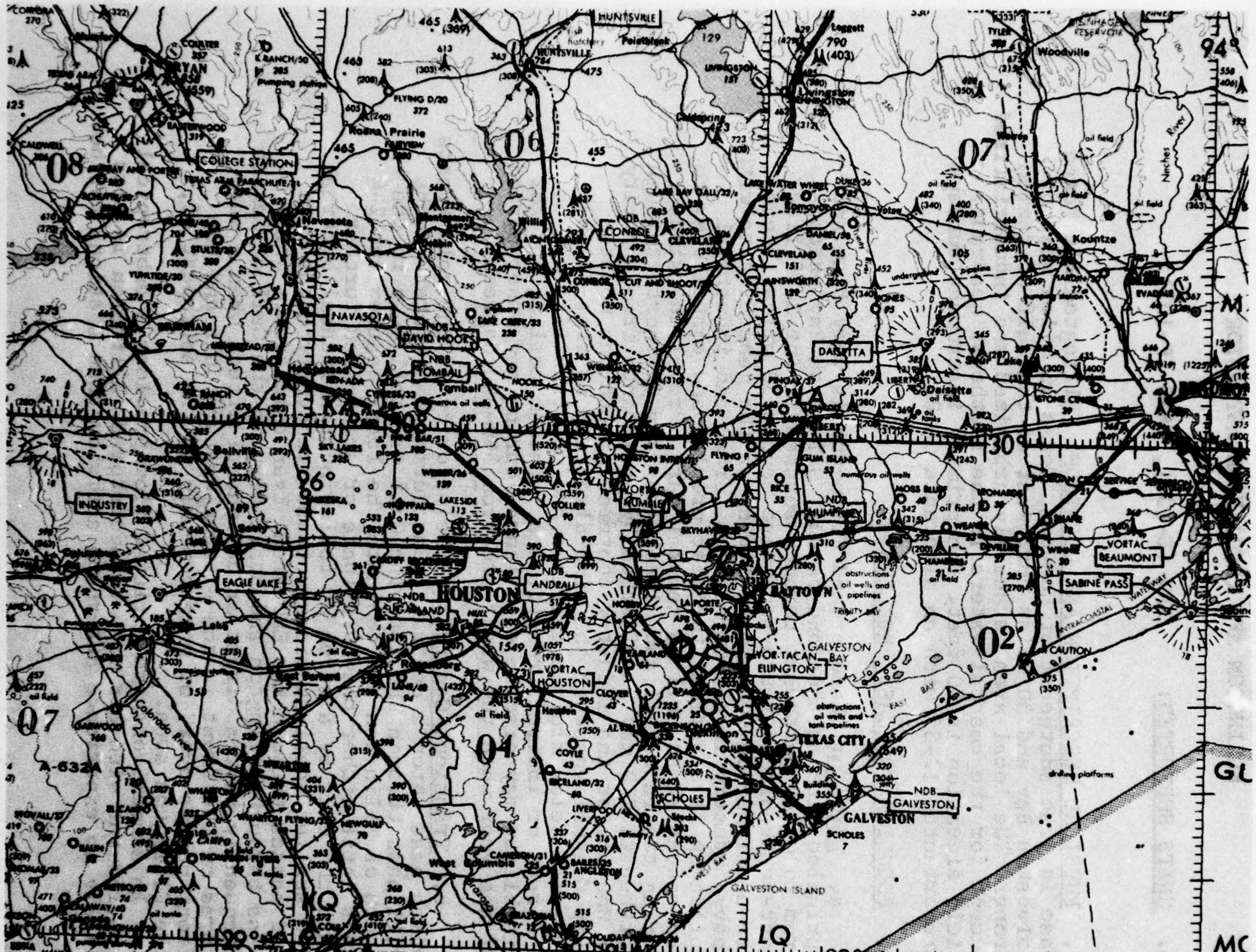
2. PHYSICAL DESCRIPTION AND LOCATION: Ellington Air Force Base is just southeast of Houston, Texas 10 miles west of Galveston Bay and 30 miles northwest of the Gulf of Mexico proper. The local area is heavily urbanized and industrialized except for the coastal waters in the southeast quadrant. Field elevation is 40 feet. The primary instrument runways are oriented 17-35 with an alternate 04-22.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Land around Ellington is very flat and sprinkled with marshes and bayous. Galveston Bay extends from 20 miles northeast through southeast. The Gulf lies east-southeast to south-southwest beyond 30 miles. There are nearly 2,500,000 people living in the general area with heavy industry in all directions. Urban and industrial pollution is a serious forecast problem and contributes to fog potential as well as general haze. Prevailing winds during the late fall and winter are from the north through northeast. EFD may be affected by pollutants from the city of Houston or the industry centered around the Houston Ship Channel whenever the wind direction is from 340-080 degrees. Below minimum ceilings and/or visibility can be a direct or indirect result. Near minimum ceiling and /or visibility may also be experienced during any other period of the year when the winds are from 340-080 degrees.

b. Transient Controls: The majority of the cold fronts which pass through central Texas during the winter months will pass through EFD into the Gulf or stall just to the south of Ellington and dominate the local weather for 2-4 days until either they dissipate or are pushed further into the Gulf by a stronger following continental outbreak. The stalled quasi-stationary front frequently turns warm and passes through the EFD area. Even cold fronts which pass through Ellington and stall deep in the Gulf of Mexico frequently have a direct or peripheral effect when a wave forms on the front in the extreme western Gulf and the front passes over, or more commonly to the southeast of, the Ellington area.

In summer, onshore maritime flow provides a subtropical environment with air mass thunderstorms. Ellington is less likely to experience afternoon activity than stations further


HUNTSVILLE
COLLEGE STATION
NAVASOTA
DAVID HOOKS
TOMBALL
CONROE
DAISETTA
INDUSTRY
EAGLE LAKE
HOUSTON
ANDRAU
SUGARLAND
VORTAC HOUSTON
BAYTOWN
GALVESTON BAY
ELLINGTON
TEXAS CITY
SCHOLES
GALVESTON
GALVESTON ISLAND
VORTAC BEAUMONT
SABINE PASS
Woodville
Kountze
Livingston
Huntsville
Navasota
Liberty
Daisetta
Cleveland
Tomball
Bellville
Colorado River
oil field
CAUTION
drilling platforms
obstructions oil wells and pipelines
A-632A

inland since developing cells are rarely mature when passing over the station. Although EFD is susceptible to severe air mass thunderstorms, it is much less so than stations to the west, north and east. On the other hand, the southwest-northeast orientation of the coastline causes the area to experience late night Gulf thundershowers that come toward land in the prevailing southeasterly flow. Minor tropical disturbances, particularly easterly waves, behave in a similar manner. Severe weather may occur with pre-frontal squall-lines, Gulf warm fronts in winter and with intense areas of thunderstorm activity in the Gulf during summer. Tornadoes and waterspouts in the general area are not rare.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Ellington is influenced by high pressure cells moving through the Upper Mississippi Valley and drifting to the East Coast. Frontal passages are not likely. The flow aloft will tend to be light northwest to northeast, so pollution is a problem. Low inversions at sunrise in the absence of Gulf flow may lower visibility to category B or C. In many instances, the pollutants will attract enough moisture to create a category B or C ceiling before or as the visibility begins to lift.

b. Type B: The Great Basin High tends to periodically invade the Southern Plains and may stagnate as it moves into the Southeast. Weak cold fronts precede the high. Waves may form on the training cold front once it moves into southern Texas or the Gulf.

(1) Cold Front: Stations north and west should be monitored to determine if the front is active. Some fronts will be dry, while others will be accompanied by high middle clouds, some D category stratocumulus and a chance of isolated showers or thunderstorms near the front. With the following anticyclone, stagnation is even more possible than in Type A due to the increased subsidence.

(2) Gulf Low: Stalling cold fronts tend to wave in the central or northern Gulf and move out into the Atlantic or up the East Coast (See Type B_1). Category D stratocumulus will persist with showers until the wave reaches southern Alabama or a corresponding point in the east central Gulf. If the wave forms in the extreme western Gulf, lower ceilings and visibility will accompany steady rain until the low is safely east of the area. (See also Type E).

c. Type C: Frontal activity is well north of the area normally with ridging over the Southeast drawing in moist southerly flow. The exact conditions will depend on the

synoptic activity in the Plains. In the absence of significant frontal activity, conditions resemble Types A and B with category D haze possible through much of the day and night. If strong southerly inflow occurs, be aware of possible category C stratocumulus ceilings, part of a wide area of eastern Texas affected.

d. Type D: Active cold fronts are likely to move past the station ahead of moderate continental polar outbreaks.

(1) Cold Front: Category D stratocumulus and middle cloud lowers to C nimbostratus in showers or light steady precipitation. Monitor stations to the north to determine the intensity. Cloud ceilings will generally be a few hundred feet higher than stations to the northwest. On some occasions, cloud-free conditions will exist prior to until just after frontal passage. If the front is slow-moving, expect conditions one category worse until the front has cleared the area completely. In late winter, a squall-line may precede the front.

(2) Anticyclone: No problems exist after the front moves out of the area until the surface ridgeline moves east of the station, and relatively warm air moves in from the south. Land areas are cool, so available moisture plus a low inversion at night encourage B category radiation fog and possible B stratus. If gradient winds are over 20 knots, the stratus may be advected inland to the north.

e. Type E: Conditions in winter are rather severe in Texas with this southerly version of the Colorado Low. Systems may develop in the Panhandle or the western Gulf depending on the location of cold air on the surface and the movement of the upper air support with respect to the developing surface low. It also depends on how far south in the Plains the arctic air is already established. If temperatures are in the teens as far south as the Red River, the low will develop in the extreme western Gulf (as a rule). Regardless of where the low forms, it will be followed by the most intense continental outbreak. Thunderstorms may precede the cold front.

(1) Cold Front (Panhandle Low): Resembles the cold front from Type D except that the front tends to move more rapidly which of course speeds up the clearing, if in fact clouds form at all.

(2) Gulf Low: Systems that develop over or south of EFD, (Type E), provide the station with a taste of warm frontal overrunning. The low will move slowly up the coast. As it develops, expect category D stratocumulus and heavy higher clouds to rapidly lower to category B. Visibility will be category C in fog with continuous precipitation. This may lower further to B as northeast flow draws in particulate matter from the Ship Channel.

Thunderstorms are also likely around the low. Ceilings will improve to category C with unrestricted visibility as winds back to the northwest and the low moves into the western Gulf states. Very gradual clearing will follow.

f. Type E_s: In this case, wave development is especially favored as low latitude impulses move in aloft from the west. These waves develop in somewhat more zonal flow and move from just southeast of Ellington towards Florida. Category D stratocumulus and middle clouds are likely throughout development until the low gets to the central Gulf. Precipitation is light and intermittent, but again with a northeast drift of the wind, visibility restrictions may be greater than anticipated.

SUMMER

a. Type B: The Bermuda Ridge dominates the weather over the Southeast in this pattern with little chance of a frontal passage. Southerly flow may be strong in late spring if storms are developing in the Central Plains. By mid-summer, flow is weak and maritime air dominates.

b. Type E: Fast-moving cold fronts move in from the northwest generating lines and clusters of thunderstorms in the afternoon and evening. Fine lines are also possible at other times of the day, and dry passages are entirely possible but unlikely.

5. SEASONAL FORECAST RULES:

SUMMER:

a. Easterly waves move 4-6 degrees longitude per day and are hard to monitor from shore stations. The best way is to keep track of thunderstorm activity on satellite pictures. Keep in mind that activity is weakest in the evening. The orientation of the coastline makes onshore movement of the wave possible.

b. Air mass thunderstorms are most likely between midnight and sunrise when offshore and noon to sunset when inland.

c. If towering cumulus is reported at EFD by 1000L, thunderstorms will occur that day.

d. Ceilings at EFD rarely go below 3,000 feet in air mass thunderstorms.

e. Air mass thunderstorms will not produce hail or winds in excess of 25 knots at EFD.

f. Convective activity in the local area must exceed 26,000 feet before thunderstorms are likely.

g. If there is a scattered deck of middle clouds at EFD at sunrise and it persists for a few hours after sunrise, air mass thunderstorms will occur that day.

h. If the morning visibility at EFD is restricted by dense radiation fog (category A,B,C), there will be no thunderstorm activity that day. If restrictions are caused by pollutants only, the rule is not valid.

i. Cold frontal passages are extremely rare in the months of June through September. Cold fronts approaching from the north or northwest and oriented northeast-southwest or east-west during April and May tend to stagnate and/or move very slowly. Once passed, they tend frequently to return as warm fronts.

WINTER

a. If the 1800L temperature is above 70°F, there will be no radiation fog at EFD the following morning.

b. If a morning category B or A stratus situation with northeasterly flow (010-080°) and visibility in category D exists, expect no change in ceiling category through the daylight hours.

c. In the same situation with southerly flow and no altocumulus above, expect C category ceilings by 1700Z.

d. If 10Z conditions are clear and 10 miles with calm or light southerly winds, forecast no restrictions to visibility through sunset. Exception: $T-T_d$ of 3 degrees or less invalidates this rule. This rule also works without taking wind into consideration.

e. If 10Z visibility conditions are A or B category and the surface winds are calm or from any direction other than northeast, E category will occur by 16Z.

f. Cold fronts oriented east-west or near east-west tend to stagnate in the EFD area and frequently produce long periods (1-3 days) of category B or C ceilings.

g. Cold fronts oriented north-south tend to slow down slightly but usually pass through the area without stopping. In concert with Gulf wave formation, they tend to return as warm boundaries in 36-72 hours. Some category C or B ceilings can be expected as the wave passes to the southeast.

REGION 13

LOWER MISSISSIPPI VALLEY AND GULF COAST
FORECAST GUIDES

Little Rock AFB	LRF
Blytheville AFB	BYH
Barksdale AFB	BAD
ENGLAND AFB	AEX
Columbus AFB	CBM
Keesler AFB	BIX
Maxwell AFB	MXF
Craig AFB	SEM
Ft. Rucker - Cairns AAF	OZR
Ft. Benning - Lawson AAF	LSF
Eglin AFB	VPS
Hurlburt Field	HRT
Tyndall AFB	PAM

LITTLE ROCK AFB (LRF) FORECAST GUIDE

1. UNITS SUPPORTED: 314 TAW (C-130), 308th SMW.

2. PHYSICAL DESCRIPTION AND LOCATION: Little Rock Air Force Base lies 12 miles north-northeast of Little Rock in central Arkansas. Although the immediate terrain is low, the Ouachita and Boston Mountains rise west and north of the base. Hills as high as 1,500 feet rise within 50 miles in those directions. The Arkansas River flows through Little Rock, over 10 miles southwest of the base, and there are several reservoirs in the hills beyond 10 miles. The Gulf of Mexico is 375 miles south. Field elevation is 311 feet, and the runway is oriented 06-24.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Little Rock Air Force Base is in a rural setting except to the south towards the city. There are several creeks and ponds locally to supply moisture. The mountains northwest retard fronts somewhat and reduce their severity by creating a "rain shadow" (reduced precipitation and squall-line activity). In summer, thunderstorms develop and tend to remain over the mountains. Because mountain barriers are lacking south and southwest, however, moisture bearing storms from this direction are neither weakened nor diverted. Local urbanization from Little Rock and industry at Pine Bluff 40 miles south cause haze.

b. Transient Controls: Most cyclonic systems in the Southern and Central Plains pass rather near Little Rock. Though many Gulf waves remain well south, winter storms may produce some snow or freezing precipitation. Severe continental polar outbreaks may only be modified somewhat when they arrive. Squall-lines are quite common late in the winter half of the year and into the summer. Air mass thunderstorms are substantially less extensive than in areas further south.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Continental polar outbreaks pass by to the north and northeast of the station. If the front passes, it will be dry in many cases. If very slow-moving, some C category stratocumulus is possible, but the mountains shelter the base quite well.

b. Type B: Maritime polar air moves into the area behind a weak front. Highs tend to stagnate over the lower Mississippi Valley. Occasionally, Gulf waves will develop on the trailing front (Type B_1), but the extent of the weather is too small in the northwest quadrant to affect LRF.

CHEROKEE VILLAGE
WALNUT RIDGE
Black Rock
Hoxie
Strawberry
Cave City
NDB
BATESVILLE
Swifton
Tuckerman
NEWPORT
Bradford
Bald Knob
NDB
SEARCY
Griffithville
Cotton Plant
Brinkley
FEDERER
Des Arc
NDB
TONEYVILLE
TACAN
JACKSONVILLE
LITTLE ROCK AFB
LITTLE ROCK
CARLISLE
HAZEN
STUTTGART
Clarendon
Pine City
St. Charles
De Witt
PINE BLUFF
Sheridan
Mount Vernon
Greenbrier
Quitman
Heber Springs
Pangburn
Pleasant Plains
Clinton
Shirley
Marshall
Hector
DIAMOND CITY
Center Ridge
Russellville
Dardanelle
ARKANSAS RIVER
MORRILTON
NDB
MORRILTON
PETIT JEAN
England
Carthage
Sparkman
Gurdon
Grady
Watson
NG
PG
NE
PE
36°
35°
34°
92°
93°
24
17
19
06

(1) <u>Cold front</u>: Category D clouds and light showers or isolated thundershowers develop on the front. Conditions normally improve rapidly after passage.

(2) <u>Anticyclone</u>: Not a problem unless the high stalls. If the center of the system is near Little Rock, morning visibility may be category D. As the high drifts east, watch for possible stratus in the return flow. Clouds would be category C stratocumulus in any case. Keep an eye on eastern Texas.

c. <u>Type C</u>: Frontal activity generally remains north of the mountains with the most likely position of the front near St. Louis. Southerly flow remains over Little Rock. Stagnating conditions may occur, but cyclonic activity along the front may draw in a lot of stratus and stratocumulus. A strong high is apt to be present over the Southeast. If the front does move south of the station, expect overrunning conditions with B category ceiling and visibility in drizzle or freezing precipitation (not likely).

(1) <u>Southerly Flow</u>: Stratus appears first in the east Texas, Louisiana and western Gulf area and rapidly moves north depending on the intensity of the inflow. If the low-level jet axis is over Little Rock, expect category C clouds with category D haze in the morning. Clouds persist through the day possibly only briefly breaking up in the afternoon. Showers and isolated thunderstorms can occur but are unlikely unless a front is in southern Missouri.

d. <u>Type D</u>: Low systems pass well to the northwest on their way to the Great Lakes. The cold front that follows precedes a moderate continental polar outbreak.

(1) <u>Cold Front</u>: Category C clouds and middle clouds precede the front which may hang up in the mountains for a few hours. Isolated thunderstorms may also develop there and drift toward Little Rock. When the front arrives, expect category B clouds and C visibility in rain or snow flurries. Stratus will persist as category B or C for several more hours after the front, but precipitation and visibility restrictions will be absent. .

(2) <u>Anticyclone</u>: The cold continental air becomes a problem as the high passes on, and return flow overruns its western edge. Category B stratus may persist day and night with some fog and intermittent drizzle until a sufficient air mass modification has taken place to eliminate the effects of overrunning.

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FORECAST GUIDES USED FOR THE CENTRALIZED TERMINAL FORECAST PROG--ETC(U)
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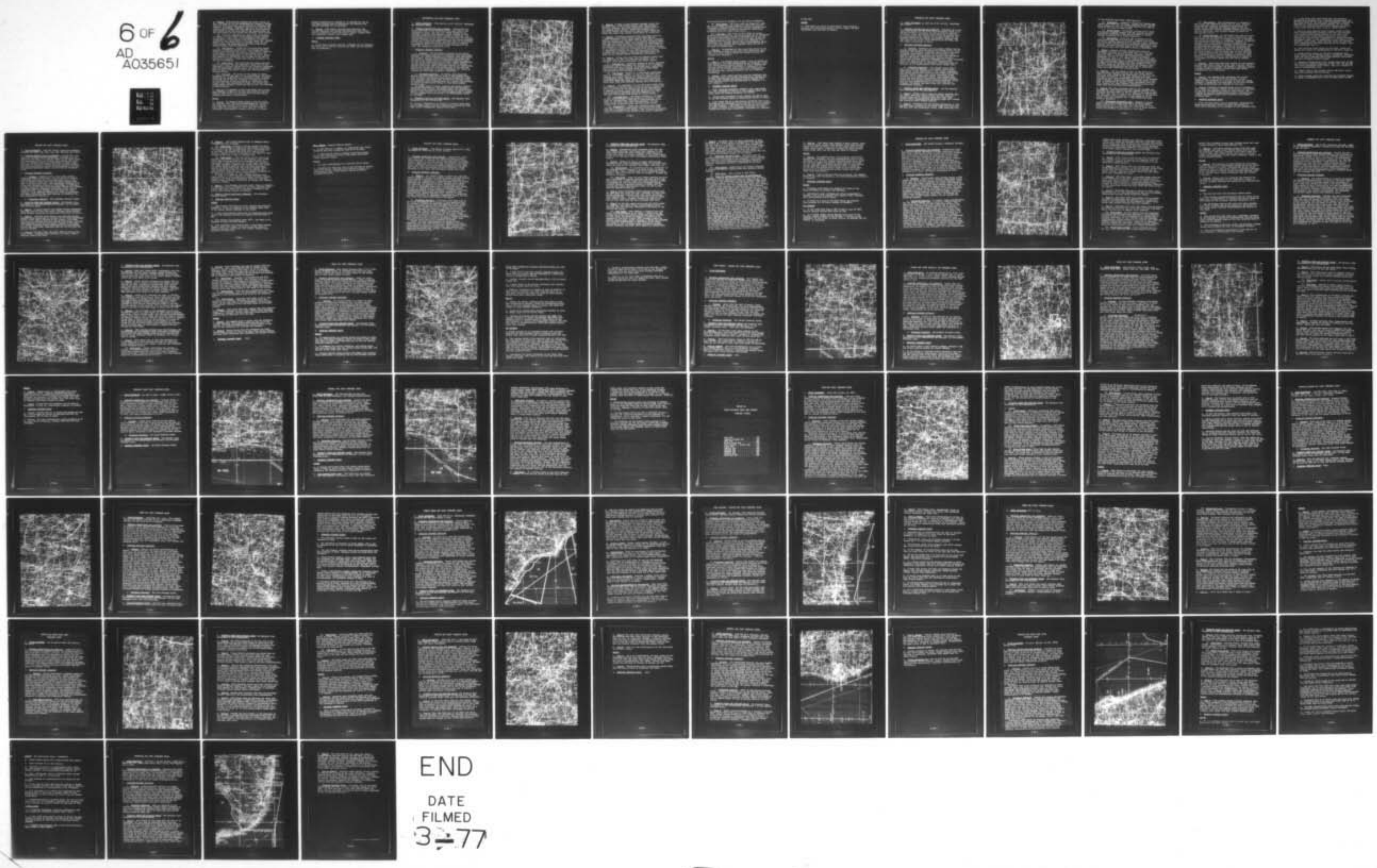

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3-77

e. Type E: This pattern produces the worst weather at LRF. The track of the low determines the forecast. Normal track is from just north of the station to Louisiana and anywhere in between. Panhandle lows move by close to the station, while Texas Gulf lows pass by to the southeast. Both tracks go up the west side of the Appalachians, so LRF will always be well within the cyclonic cloud shield.

(1) With the Panhandle Low, warm front overrunning is likely at Little Rock. Deterioration occurs quickly to category B with onset of precipitation. Category A conditions may occur right on the front along with thunderstorms, but the clouds break up rapidly after the warm front passes. The mountains do not affect warm front weather moving from the southwest.

(2) Warm Sector: Clouds are scattered with patchy category D ceilings. Squall-lines may precede the cold front in the afternoon or evening. Such activity tends to be directed toward the south of the station or to the north around the mountains. If the line is solid, expect the mountains to retard the line an hour or two and to reduce its intensity. Cloud bases will be category C if the line is moderate.

(3) Cold Front: The front will not behave the same way in all cases. The two features to look for are the continental outbreak behind the low and backwash associated with the developing occluded wave. The weather resembles that of Type D cold fronts except that the outbreak is moderate-strong.

(4) Gulf Low: The track of this storm is across Louisiana up the west side of the Appalachians. The cloud shield may be reinforced by an inverted trough extending northward out of the low. Category C clouds lower to B in precipitation as the wave moves by. Visibility will improve after the precipitation stops, but clouds will remain below category D until the low is well into Kentucky or West Virginia.

f. Type E_a: Development of this wave takes place in the same location as Type B_1 but then moves pretty much due eastward after that. As a result, only D category altocumulus will occur at Little Rock.

SUMMER

a. Type B: The Bermuda Ridge allows a flow of marine air into the area. Air mass thunderstorms are common in the mountains; less so at the base. Southerly inflow will cause broken cumulus at times with the chance of afternoon thundershowers. Showers and haze may reduce

morning visibility to category D. If grounds are wet in the early morning from precipitation the previous day, sunrise radiation fog is possible.

b. Type E: Cold fronts approach from the north and trigger afternoon and evening thunderstorms which often form in clusters or lines and can be severe. Passage over the mountains, however, will weaken them.

5. SEASONAL FORECAST RULES:

SPRING

a. Little Rock receives category C stratus if the southerly low level jet is 100-130 miles to the west, and the surface flow is southerly.

BLYTHEVILLE AFB (BYH) FORECAST GUIDE

1. UNITS SUPPORTED: 97th Bomb Wg (B-52, KC-135). Tennessee Air National Guard.

2. PHYSICAL DESCRIPTION AND LOCATION: Blytheville Air Force Base lies in the lowlands on the west side of the Mississippi River, very near the common boundaries of Arkansas, Missouri and Tennessee. Local terrain is flat and cultivated with many local sources of moisture. The Mississippi River is 11 miles east of the base. The nearest terrain features of any consequence are the Boston Mountains rising over 2,000 feet higher 180 miles west of Blytheville. The largest population center near the base in Memphis, Tennessee 55 miles to the south. Field elevation is 254 feet, and runway orientation is 17-35.

3. PECULIAR FORECAST PROBLEMS:

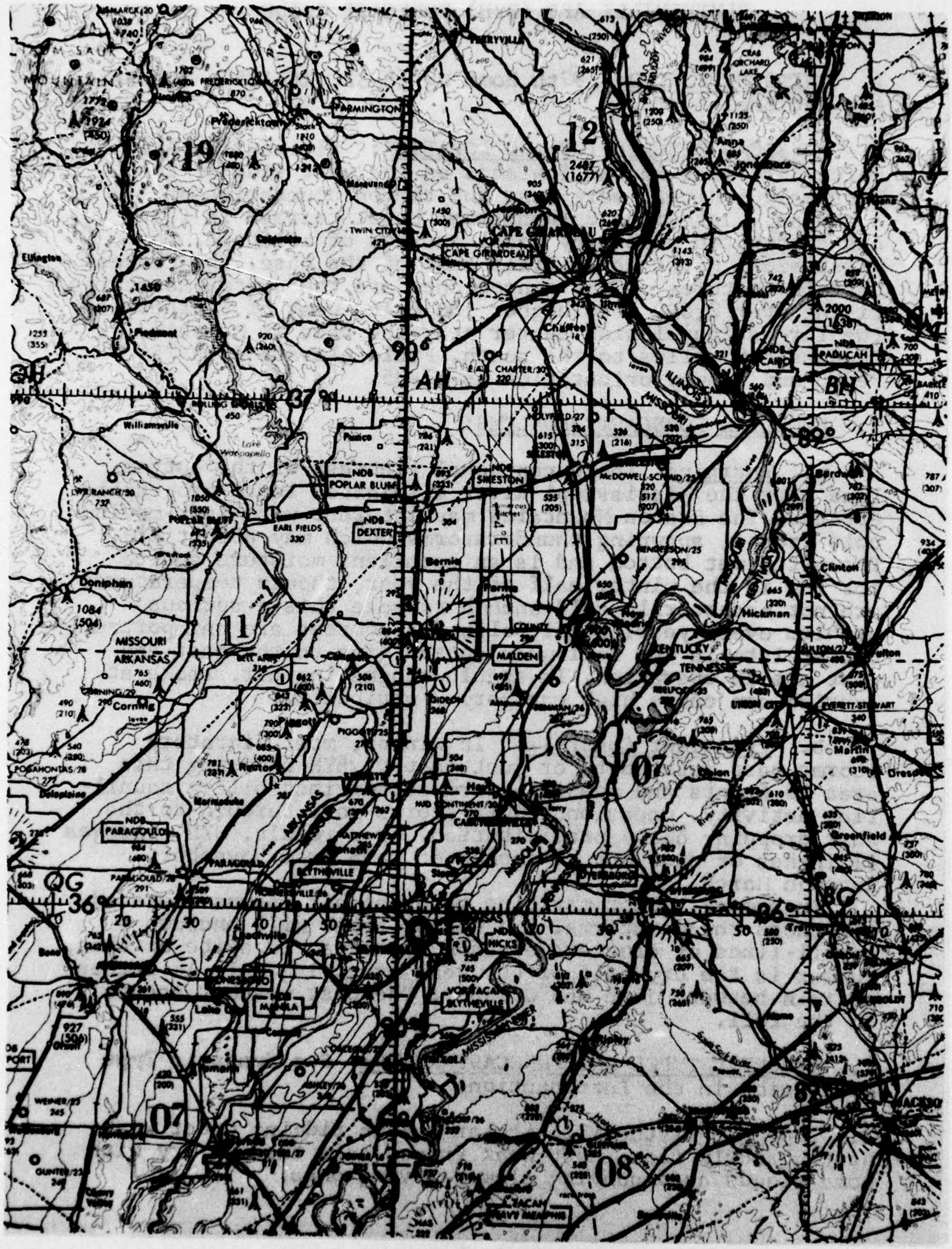
a. Terrain: The exceptional flatness of the bottom land near the Mississippi River eliminates local orographic effects. The Boston Mountains may interact with fast-moving cold fronts, spawning thunderstorms which may affect BYH, The often wet bottom and is an excellent moisture source for fog in the winter half of the year, though temperatures are not necessarily cold enough to make this a serious problem every year. Local pollution sources are unimportant, except late in the fall when cotton gins to the east and west are in operation. In stable stagnating air, smoke at sunrise can cause high category D visibility.

b. Transient Controls: In winter, most migratory storms pass just north or just east of BYH exposing this area to fronts and possible warm sector instability squall-line activity. Occasional Gulf storms move through to the east dropping heavy precipitation. As a result, BYH averages 11 inches of snow and 23 inches of rain from November through March.

In summer, moist maritime tropical air spawns isolated afternoon thunderstorms. Any nearby front will encourage squall-lines or clusters of thunderstorms. In spite of this, summer is the dry half of the year averaging only 14 inches of rain between June and October. The best weather occurs in the fall.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Blytheville is largely in ridging under weak northwesterly flow. Most weak fronts pass through dry with some clouds accompanying slower-moving ones.


FARMINGTON
CAPE GIRARDEAU
TWIN CITY
Ellington
Piedmont
Williamsville
Lake Wappapello
NDB POPLAR BLUFF
NDB SIKESTON
NDB DEXTER
EARL FIELDS
Doniphan
MISSOURI
ARKANSAS
Corning
POCAHONTAS/28
NDB PARAGOULD
MALDEN
KENTUCKY
TENNESSEE
Hickman
Clinton
UNION CITY
EVERETT-STEWART
Greenfield
Martin
NDB PADUCAH
CAIRO
BLYTHEVILLE
NDB HICKS
VORTACAN BLYTHEVILLE
NAVY MEMPHIS
WEINER/25
GUNTER/23
Dyersburg
Mud Continent/30

b. Type B: A band of high pressure extends across the southern half of the United States. When this pattern prevails, however, the lower Mississippi Valley lies at the weakest point usually. Conditions resemble Type A generally except that stagnating anticyclones behind the front will cause some morning restriction to visibility.

c. Type C: Prolonged southwest flow encourages waves on a quasi-stationary front which usually lies through central Missouri. On the south side of the front, southerly flow and occasionally broken C or D category ceilings exist. Some haze also occurs along with showers or thundershowers as waves move along the front. The front may slip south of the station if a cold high drops across the Canadian Border. If so, forecast classical overrunning with category B stratus, C visibility, drizzle and fog (freezing precipitation possible but not likely). Front may oscillate north and south of the station making forecasting a nightmare.

d. Type D: Strong lows pass from the Central Plains into the Great Lakes. BYH gets warm sector weather with a moderate polar outbreak following cold front passage.

(1) Warm Sector: Migratory stratus in strong southerly inflow will cause persistent low category D or C ceilings. Visibility will be D category in morning haze. Instability line may bring severe weather ahead of the cold front particularly in the afternoon or evening.

(2) Cold Front: Expect up to four hours (sometimes more) of B category clouds, fog and rain improving to C category for 6 more hours if the front is moving. After precipitation stops, visibility improves and becomes unrestricted under the cloud ceiling. If low clouds exist after dark, they will probably continue into mid-morning.

e. Type E: The Panhandle low with this type moves right over BYH to the Appalachians, while the Gulf low moves just to the southeast of the station and up the Appalachians. A moderate to strong polar outbreak follows this system. Severe weather is possible with the Panhandle Low. BYH lies well within the cloud shield of either system.

(1) Panhandle Low: Warm front overrunning is likely at BYH. Deterioration occurs quickly to category B with onset of precipitation. Category A conditions may occur right on the front along with thunderstorms, but the clouds break up quickly after the warm front passes.

(2) Warm Sector: Clouds are scattered with patchy category D ceilings. Squall-lines may precede the cold front in the afternoon or evening. Such activity is directed toward Blytheville by the action of the Boston Mountains.

Cloud bases will be category C if the line is moderate.

(3) Cold Front: The front will not behave the same way in all cases. The two features to look for are the continental outbreak behind the low and the backwash with a rapidly deepening occlusion. The weather experienced resembles that of a Type D cold front.

(4) Gulf Low: The track of this storm is always southeast of the station. The cloud shield may be reinforced by an inverted trough extending northward out of the low. Category C clouds lower to B (or to A if snow occurs) in precipitation until the low is well into Kentucky. The visibility will rapidly improve after precipitation stops, but C category ceilings will continue until the low is at least to Pennslyvania.

f. Type E_s: Development of this wave takes place in the same location as Type B_1 but then moves almost due eastward after that. Middle clouds are likely at times but probably not category D.

SUMMER:

a. Type B: The Bermuda Ridge allows a flow of marine air into the area. Air mass thunderstorms are isolated. Southerly inflow induces broken cumulus at times. Showers and haze may reduce morning visibility to category D. If grounds are wet in the early morning from precipitation the previous day, sunrise radiation fog is a distinct possibility.

b. Type E: Cold fronts approach from the northwest and trigger afternoon and evening thunderstorms. Organization in lines and clusters may produce severe weather and a basic ceiling around the thunderstorms of category C or more likely D.

5. SEASONAL FORECAST RULES:

a. Tight southeast-northwest gradient will cause winds from the southwest to gust up to the gradient level wind speed after the morning inversion has broken.

b. Anticyclonic curvature at the surface and 850 mb wind in the BYH vicinity means no thunderstorm activity locally.

c. With either BYH in a post-frontal situation with a low centered to the northeast of the station, or a high situated over New England - - and winds at BYH out of the northeast or north, forecast B or A category visibility for early morning with only slow improvement throughout the remainder

of the day.

WINTER

a. Warm moist air ahead of warm fronts causes category B ceilings and visibilities when it has at least a 24-hour trajectory over the Gulf of Mexico.

BARKSDALE AFB (BAD) FORECAST GUIDE

1. UNITS SUPPORTED: 2d Bomb Wg (B-52, KC-135). Louisiana ANG (A-37).

2. PHYSICAL DESCRIPTION AND LOCATION: Barksdale Air Force Base lies across the Red River from Shreveport which is in extreme northwest Louisiana 175 miles north of the Gulf of Mexico. There are several local lakes and marshes with no significantly high terrain in the area except for the Ouachita Mountains in central and northern Arkansas over 100 miles to the north. Field elevation is 167 feet, and the runway orientation is 14-32.

3. PECULIAR FORECAST PROBLEMS:

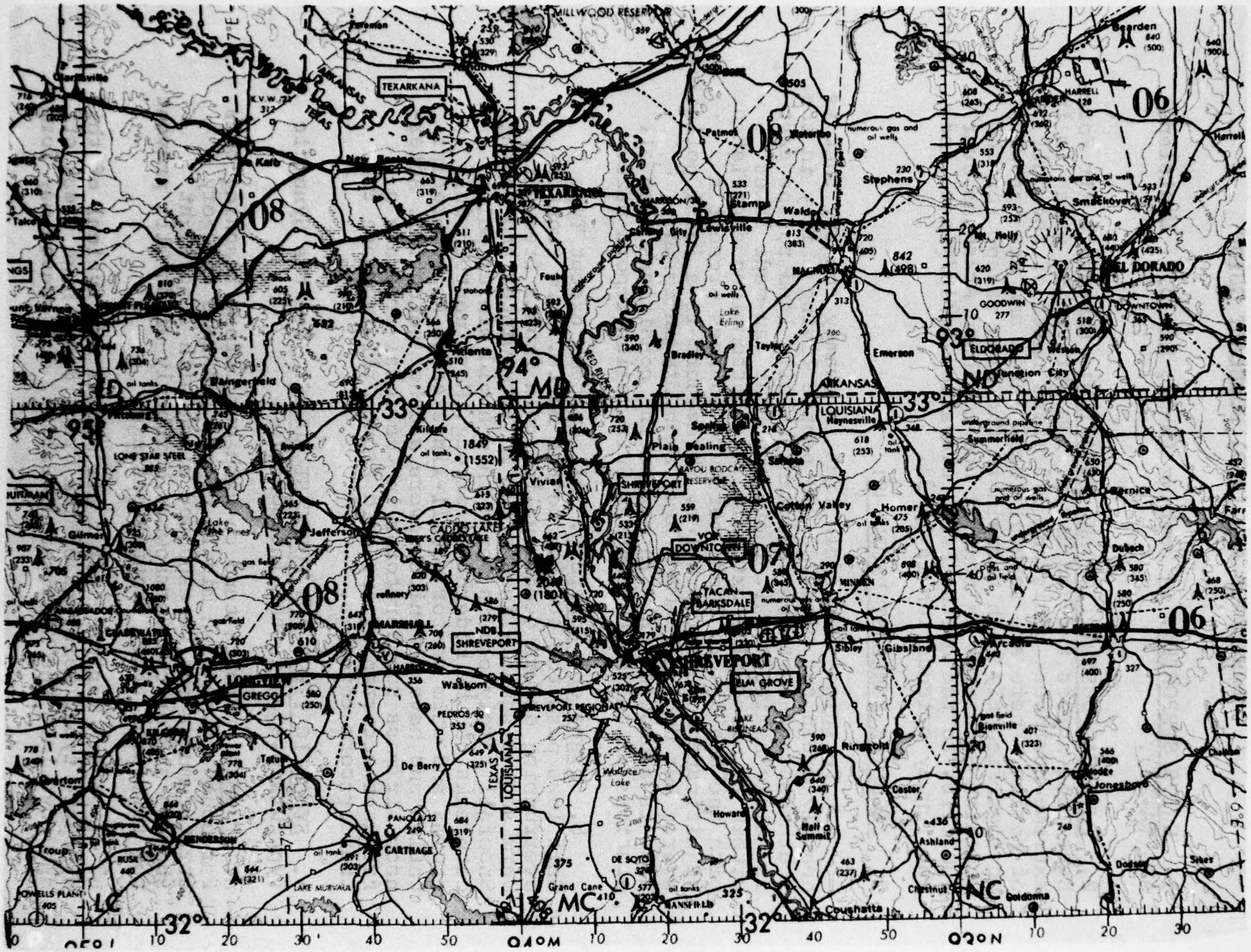
a. Terrain: Barksdale lies in swampy country that is heavily urbanized with 200,000 people living mainly in the southwest and northwest quadrants, while land to the east is mainly agricultural. There are four man-made lakes within 25 miles plus extensive wet bottom land associated with the Red River. These moisture sources present a significant forecast problem. Shreveport is a local pollution source but does not affect local visibility particularly. Haze is a problem only in stagnating conditions when all stations in the south-central Gulf region report haze.

b. Transient Controls: All systems except Type E Gulf lows pass the station to the north. Warm frontal overrunning occurs occasionally; cold fronts frequently. Warm sector squall-lines occur in late winter and spring. Snowfall rarely occurs, even though mid-winter polar outbreaks can be moderately strong. Most western Gulf storms and warm sector squall-lines cause heavy precipitation and have definite severe weather potential. Afternoon air mass thunderstorms in the local area are a frequent occurrence. Any cold front will increase the thunderstorm coverage.

4. SYNOPTIC TYPES AND FORECAST RULES: See the Synoptic Type Discussion in the Introduction.

a. Type A: Fronts tend to wash out before reaching this far south. Some high middle clouds and some category C stratocumulus may be expected along with some light showers and/or thundershowers.Northerly winds will prevent fog formation after frontal passage.

b. Type B: Maritime polar air masses are typical of this synoptic type. Portions of the Great Basin High break off and move into the Mississippi Valley. Gulf waves may form



TEXARKANA
MILLWOOD RESERVOIR
ARKANSAS
TEXAS
LOUISIANA
EL DORADO
ELDORADO
Stephens
Magnolia
Lewisville
Stamps
Smackover
Junction City
Haynesville
Homer
Minden
Bernice
Sibley
Gibsland
Arcadia
Vivian
Plain Dealing
SHREVEPORT
DOWNTOWN
BARKSDALE
ELM GROVE
Bossier City
CADDO LAKE
Jefferson
Marshall
LONGVIEW
GREGG
Waskom
De Berry
CARTHAGE
HENDERSON
Troup
Overton
Gilmer
Kilgore
LONE STAR STEEL
Pittsburg
Daingerfield
Atlanta
New Boston
Kelt
DE SOTO
Grand Cane
MANSFIELD
Coushatta
Ringgold
Castor
Ashland
Jonesboro
Dodson
Goldonna
Bienville
Howard
Emerson
Taylor
Bradley
Lake Erling
Summerfield
Dubach
Bearden
Harrell
GOODWIN
33°
32°
94°
93°
94°W
93°N
06
07
08

on the trailing cold front. (See Type B_1).

(1) Cold Front: Category D clouds with showers may precede the front for 3-6 hours. Clearing occurs rapidly after passage as long as the front does not get hung up close to the coast by wave action.

(2) Anticyclones: Stagnating maritime polar highs are massive sluggish systems that may persist for days. Subsidence inversions cause haze and smoke to reduce morning visibility to at least category D.

(3) Gulf Waves: Waves are apt to develop on the quasi-stationary front in the Gulf. Movement from there is across southern Georgia and up the East Coast. Barksdale will be in the extreme north or northwest quadrant of such systems. The base receives layers of high and middle cloud and little less. (See also Type E which is different).

c. Type C: Frontal activity remains well north of Barksdale. Movement of a cold front this far south and east with Type C is almost unknown. Therefore, stable southerly flow is the rule and resembles stagnating conditions of Type B as a rather strong high exists over the Southeast with Type C. If the onshore flow of moisture is well established, expect category C stratocumulus late at night and in the morning with some category D haze. If the front moves as far south and east as Arkansas, some showers and thundershowers may break out as waves move along the front under weak troughs aloft.

d. Type D: The low system is well to the north, but a moderate polar outbreak follows the cold front. Squall-lines may occur ahead of the cold front, but BAD is a bit far south for Type D. If the high pressure cell that follows is cold, some overrunning may result on its western edge. Category C stratus may persist day and night if the flow is reinforced by another trough approaching from the west. Drizzle and light freezing precipitation can occur which will drop the visibility considerably.

e. Type E: This more southerly form of the Colorado Low provides the worst weather for BAD. Systems develop in the Panhandle and move north of BAD or form in the western Gulf and move right over or just to the southeast of the station. The following polar outbreaks are the strongest of the season. With the Panhandle Low, a warm front will form south of Barksdale.

(1) Warm Front (Panhandle Low): Category C stratocumulus and middle clouds occur up to 12 hours before front lowering to B. Visibility will also lower to C in precipitation and fog then down to B or A in heavy precipitation and embedded thunderstorms on the front.

(2) Warm Sector: Some stratocumulus in category C will occur, but scattered clouds are the rule. Thunderstorm activity possibly organized in squall-line is likely in the afternoon and evening ahead of the cold front. Weather will improve somewhat between squall-line and the cold front. Cold frontal weather is about the same as with Type D.

(3) Texas Gulf Low: The low itself may pass very near BAD but may not be developed too well at this point. The warm front and open wave is stronger than with a panhandle low because more moisture is available. Category D ceilings initiate light precipitation as the low reaches the coastal areas to the south. Gradually deterioration occurs as precipitation increases. When the low is passing the station, fog is also possible along with thunderstorms. Ceilings will be B category or lower. If the low passes 50 miles or more to the southeast, the fog will probably not significantly lower the visibility. As the low moves on, conditions will gradually improve to category C and showers. A secondary surge of precipitation is likely if a secondary cold front passes with the 700 mb thermal trough.

f. Type E_s: Gulf waves form most readily in this synoptic pattern. Most waves track due east, and a few may tend to recurve some after reaching the Atlantic. Forecast category D middle clouds, scattered C clouds and light steady precipitation for a few hours.

SUMMER

a. Type B: The Bermuda Ridge dominates the pattern. Fronts remain to the north of the station, so that southerly flow prevails. If the flow is unusually strong, category C clouds may form especially in the late morning. Air Mass thunderstorms are isolated on most days.

b. Type E: Virtually no Bermuda Ridge over the Southeast. Cold fronts move slowly through the Southeast and dissipate in the Gulf (occasionally return as warm fronts). The coverage of air mass thunderstorms greatly increases when a front approaches. Squall-line activity in the summer is fairly rare.

5. SEASONAL FORECAST RULES:

a. With the high center east of Barksdale, stratocumulus along the Texas Gulf coast will reach the station in 24-36 hours depending on the strength of the southwest flow.

b. A cold front with upper winds from the northwest through north produces B or C category stratocumulus 100-200 miles ahead of the front with rainshowers. Clearing is expected 2-5 hours after frontal passage. Two to three days of fair weather normally follow frontal passage as a high moves into the area. (Type E; rarely Type A).

c. After the high pressure ridge passes, broken to overcast cirrus/altostratus occurs to the west and southwest of the north-south central portion of the ridge. With warm moist flow, cloud layers increase as rain falls through the layers. With a Panhandle Low, clouds increase and become lower. If the temperature at all levels is below freezing, heavy icing, sleet and rain mixed are expected until temperatures are above freezing at all levels. (Type E; occasionally Type D).

d. Most maritime polar fronts in late fall, winter and spring will result in thunderstorms at the base. (Type B).

e. Clear weather occurs at BAD with a northerly flow aloft (ridge west of station aloft). Conversely, southerly upper air flow indicates short-lived clearing (less than one day) following frontal passage.

f. November through April: With surface high east of BAD, any low-level ceilings appearing at BRO, LRD, CRP and PSX will reach BAD(within 24-30 hours). This is a function of west to southwesterly flow.

g. Fronts tend to stop between Dallas and Tyler, Texas once they parallel the 700 mb wind.

h. When easterly waves are detected over southern Florida in summer, rainshowers will occur 36 hours later at BAD.

ENGLAND AFB (AEX) FORECAST GUIDE

1. UNITS SUPPORTED: 23rd TFW (A-7D). Exception amendment criteria are 1500, 700, 600, 500, 400, 300 feet and 1 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: England Air Force Base lies 3 miles west of Alexandria, Louisiana near the center of the state. The Gulf of Mexico is 110 miles south, the Mississippi River is 50 miles east and the Red River, with its extensive bayous and marshland, is three miles northeast of the base. Terrain is quite low with no hills over 450 feet within 25 miles. Field elevation is 89 feet. The primary instrument runway is 14-32 with an alternate 18-36.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: England is near very marshy country associated with the Red River. Much of the local land is cultivated except for the urban Alexandria area to the east. Extensive swamps lie along the large coastal plain over 50 miles to the south. The Atchafalaya Floodway is 30 miles east. Moisture sources are everywhere, and drainage is poor. There are many minor pollution sources that combine to produce haze in stagnating conditions. Local sources arise from fall crop burning, the city dump and light industry. Light easterly breezes will bring in pollutants and reduce visibility one more category in radiation fog than described in Section 4.

b. Transient Controls: See Barksdale Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Barksdale Forecast Guide.

a. Type A: A narrow band of high middle clouds accompanies the front plus or minus six hours. Clearing occurs rapidly after passage. Fronts do not generally reach this far south.

b. Type B: Maritime polar fronts pass followed by high pressure cells which tend to stagnate in the lower Mississippi Valley. Waves tend to develop on the trailing cold front (See Type B_1) and move into the eastern Gulf states. Isolated thundershowers occur with the front. Category C can occur with severe stagnation under influence of the anticyclone. As the high moves east, southerly flow may set up again and draw in stratus.

c. Type C: With this type, the front will not move as far south as AEX. Southerly flow prevails. If strong, some C category clouds will form.

d. Type D: Cold fronts produce weak to moderate polar outbreaks at this latitude.

(1) Cold Front: Category C clouds precede the front by less than six hours. Conditions will lower to category B at passage and for several hours after. Visibility will be category D in showers and light fog. Late in the winter, a squall-line may form ahead of the front but this is more likely with a Type E Panhandle Low.

(2) Anticyclone: With the center of the polar high following the front now east of the station, cold ground under clear skies and calm wind encourages ground fog especially if winds are light out of the east. Southerly flow also presents a problem when moving over cold ground. Fog and/or stratus moves in once the winds turn south usually 24 hours after being reported in central Texas. With gradient flow under 15 knots at low levels, fog prevails with little stratus. Expect morning visibility to be category B improving by late morning to E.

In flow of 15 knots or more, stratus prevails with bases similar to those reported by other stations; usually category B in early and mid-morning rising to C in late morning through evening. Visibility is usually one category above the ceiling.

e. Type E: See Barksdale Forecast Guide. There is virtually no difference with a Panhandle Low for both stations. With a Gulf wave, the center will pass nearly overhead at AEX and so warm frontal weather is assured.

e. Type E_s, Type B and Type E (Summer): See Barksdale Forecast Guide.

5. SEASONAL FORECAST RULES:

WINTER

a. Warm frontal positions are often located from dewpoint contrasts. It may be possible to see ceilings slope down to the actual surface position of the front.

b. A cold front between Dallas and the Louisiana State Line is the best possible position for squall-line activity at AEX.

c. With sunrise temperatures below 28°F., fog tends to be advected in from the local swamps.

d. When southerly flow returns after a cold front passage, central Texas will always get stratus one day prior to central Louisiana (36-48 hour time frame). Stratus forms initially at 0700-1100L.

FALL- SPRING (October through April)

a. Do not forecast a ceiling at 1,000-2,500 feet unless spread on low-level trajectory data is 3^o or less.

b. A northwesterly through easterly wind will greatly reduce the possibility of fog, even though sufficient ground moisture exists.

SUMMER

a. Air mass thunderstorms move with the 700 mb winds.

b. Radiation fog does not form in the presence of clouds, even thin cirrus. Northeast winds appear to reduce the possibility of fog unless nearly calm regardless of available moisture.

COLUMBUS AFB (CBM) FORECAST GUIDE

1. UNITS SUPPORTED: 14th Flying Training Wing (T-37, T-38), Detachment 2, 97th Bomb Wg (B-52, KC-135).

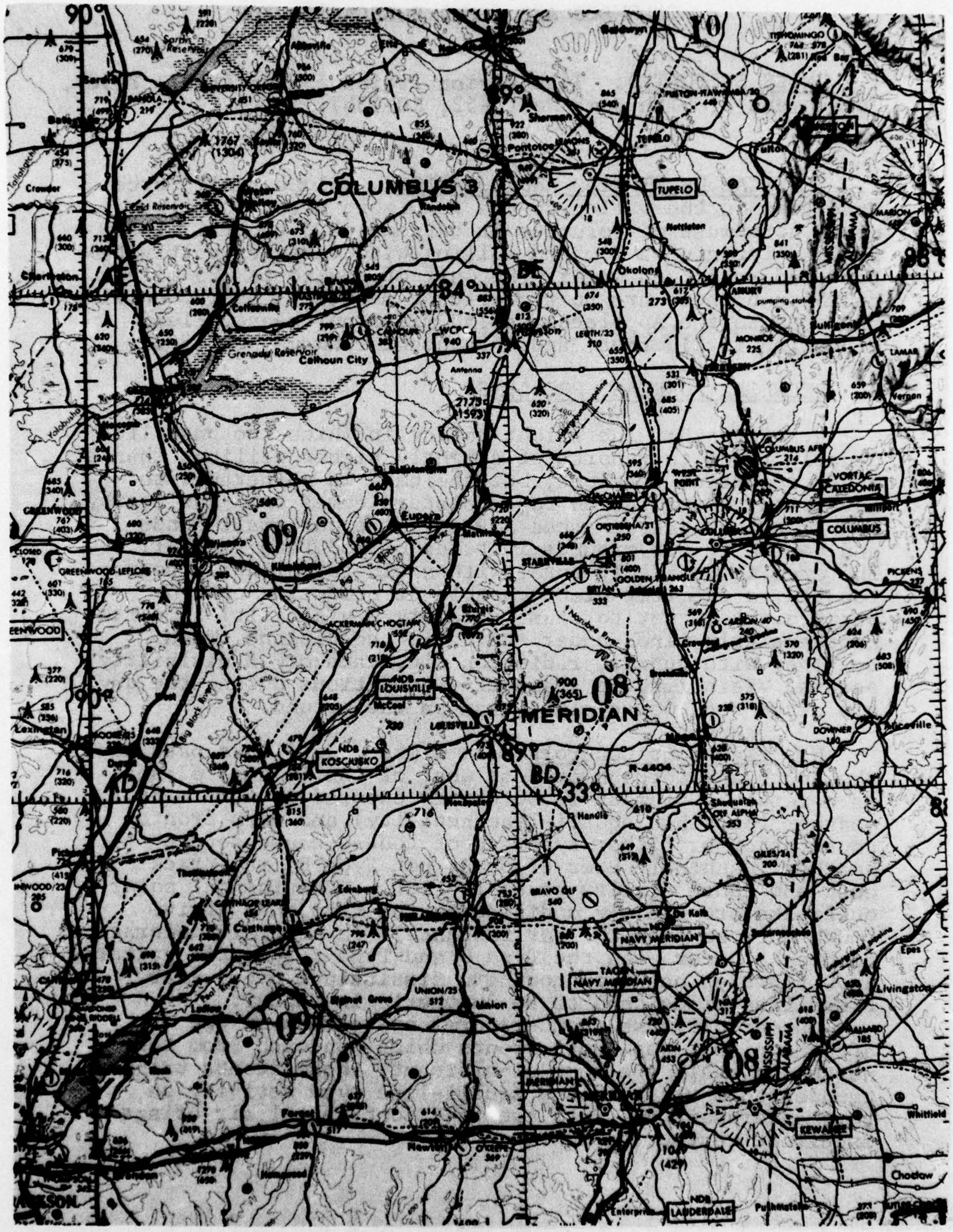
2. PHYSICAL DECRIPTION AND LOCATION: Columbus Air Force Base lies in the valley of the Tombigbee River 10 miles north-northwest of Columbus in extreme east-central Mississippi. Terrain is low and rolling with forests, cultivated land and some open water. The Gulf of Mexico is 225 miles south, and there are no significant mountains nearby until one goes to the Appalachians 150 miles northeast. Field elevation is 219 feet, and instrument runways are 13-31.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The slight valley in which the base lies usually leads to reports of slightly higher ceilings than at other reporting stations, but the base is vulnerable to advection and radiation fog. Moisture comes from the nearby Tombigbee and Buttachachee Rivers, numerous small ponds and generally wet grounds in times of moderate rainfall. The area is decidedly rural with a single pollution source locally, a chemical plant capable of producing enough particulate matter to cause category C visibility in north-northeasterly winds under stagnating conditions. When combined with sunrise radiation fog, category B visibility occurs. Visibility is stagnating conditions during the day are often much worse aloft than on the ground.

b. Transient Controls: In winter, Gulf lows pass to the south and through or just west of the immediate area. As a result, Columbus is sometimes exposed to warm sector weather (possible squall-line activity) and warm frontal thunderstorms. Either type can of course cause severe weather. Panhandle Lows (Type B, not Type E) may track east and cause similar weather briefly. Continental polar outbreaks are greatly modified by the time they arrive (much more so than LRF for instance). In general, moderate outbreaks occur with the Type D and Type E synoptic patterns. Snow flurries occur in northern Mississippi every year. Prevailing winds tend to be northerly in winter.

Summer air mass thunderstorms are common in the afternoon, but weak cold fronts which approach from the north and stall are more significant. These fronts trigger thunderstorm clusters and squall-line type activity on some afternoons and into evening. Continental air brings excellent weather to CBM.


COLUMBUS 3
TUPELO
Pontotoc
Nettleton
Okolona
Grenada Reservoir
Calhoun City
Coffeeville
Crowder
Charleston
Eupora
GREENWOOD
GREENWOOD-LEFLORE
Lexington
LOUISVILLE
KOSCIUSKO
MERIDIAN
COLUMBUS
COLUMBUS AFB
CALEDONIA
Vernon
Pickens
Starkville
Brooksville
Macon
R-4404
Carthage
Edinburg
Union
Forest
Newton
Enterprise
NAVY MERIDIAN
LAUDERDALE
KEWANEE
Livingston
Whitfield
Choctaw
De Kalb
Walnut Grove
Philadelphia
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84°
89°
33°
08
09
10

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Continental polar outbreaks push into the Ohio Valley following cold fronts that stagnate in the upper Gulf states and often dissipate. Some category D clouds will occur if passage happens. If the front stalls right in the CBM area, some overrunning difficulties could result.

b. Type B: Surface mP fronts are weak. Anticyclones stagnate in the lower Mississippi Valley or eastward. Gulf waves may form on the trailing cold front. (See Type B_1).

(1) Anticyclone: If stagnation sets in, visibility in the morning will be category D in haze; better at other times of day. When a surface high to the northeast (infrequently) draws in marine air from the Atlantic, stratus may arrive in 36 hours.

(2) Gulf Wave: Waves on cold fronts reaching the Gulf have been known to rapidly intensify and move up the East Coast (Type B_1). Middle clouds may affect Columbus as the low develops to the south and moves northeast through southern Georgia. Scattered category C clouds will also develop with light precipitation until the low is due east and clearly moving out.

c. Type C: Quasi-stationary front through Missouri will not move this far south and east. Southwest or south flow around strong high pressure cell will cause abnormally warm temperatures. If the flow from the south is abnormally strong, then C category clouds will persist for days on end. Some haze may also accompany that flow.

d. Type D: As the low center moves into the Great Lakes, the trailing cold front brings a weak-moderate polar outbreak into the CBM area. Stalling of the front in the Gulf is not likely.

(1) Cold Front: Most weather is ahead of the cold front. In the afternoon or at night, a squall-line may precede the front and possibly producing severe weather. In such cases, six hours of category C clouds can be expected on the front itself. With stronger fronts but without squall-lines, expect category C clouds and embedded but isolated thunderstorms on and ahead of the front. Visibility is not a problem except in heavier showers. Sunrise radiation fog under clear skies is a possibility.

e. Type E: Troughing aloft is more pronounced in this situation, so a wider range of weather is to be expected. The warm front of a Panhandle Low will pass through the CBM area. On the other hand, a Texas Gulf low will either pass right overhead or slightly west of the station. In this case, warm front overrunning will also occur. A moderate continental polar outbreak occurs behind this low and causes the coldest weather of the season.

(1) Panhandle Low Warm Front: The warm front is developed and will return to the northeast rather quickly. Low category C nimbostratus with category D visibility in haze, fog and light continuous precipitation should be forecast. Conditions improve to scattered in the warm sector.

(2) Warm Sector: Squall-lines are likely. Category B ceilings in heavier thunderstorms with possible severe weather.

(3) Cold Front: Same as Type D cold front.

(4) Gulf low passing either over or northwest of station: Lows to the northwest with active warm fronts often show little improvement near the triple point, while lows just to the southeast or overhead resemble warm front overrunning anyhow. For the sake of simplicity, both will be treated here the same way. Conditions begin with category D middle clouds lowering to nimbostratus. Precipitation begins as continuous light rain, and ceilings go to C. With the front onshore to the south or southwest, category B (or possibly C) and D visibility in continuous rain and fog are the rule. As the warm front nears the station, general conditions go to B clouds and visibility. Precipitation may be heavy with embedded thunderstorms. (Severe weather must be considered). As the warm front passes, conditions improve to scattered clouds. (Low to the northwest). Backwash around a rapidly developing system may bring category C stratus into the area to persist 12-18 hours into the next day. In the event of clear skies, morning radiation fog may develop. If the low passes to the southeast or is overhead, maintain the category B clouds and visibility until the low is well to the northeast. Once the colder air becomes established, clearing occurs rapidly. Then a new problem will appear as the high cell moves on to the east. Returning warm moist southerly flow will interact with cold wet ground to generate extensive low stratus and fog depending on the wind field. If the return flow is weak (less than 10 knots at low levels), category B fog is most likely from midnight to mid-morning; rising to low stratus and dissipating by noon. In stronger flow, category B or C stratus will occur throughout this time period. (A new front is often approaching in this situation).

f. Type E_s: Gulf waves form readily in this pattern. Upper air flow is split across North America. Waves move zonally across the Gulf of Mexico. CBM is far enough north so only middle cloud layers, scattered C clouds and light precipitation occur until the low hits the coast of Florida.

SUMMER

a. Type B: The Bermuda Ridge is in position and usually extends over Columbus. Air mass thunderstorms occur in the afternoon, but in large numbers only when moisture in depth and vertical motion are present. Brief sunrise radiation fog may form after a previous night's rain. In late Spring, strong southerly inflow from the Gulf will be directed to the west, but Columbus will right on the eastern edge. Category C or D stratocumulus is most likely from late night until mid-morning.

b. Type E: Fronts approach from the northwest. The Bermuda Ridge is out over the Atlantic. Air mass thunderstorm activity is enhanced.

5. SEASONAL FORECAST RULES:

WINTER

a. Migrating cold fronts are delayed 4-6 hours by the Ozark Mountains in Missouri and Arkansas.

b. Continental polar outbreaks are often accompanied by stratus, even if not apparent from synoptic data. Ceilings will often persist for 24 hours.

c. If there is a high in the Ohio Valley and easterly flow persists for 36 hours, stratus is possible.

ALL SEASONS:

a. If the 3,000 foot wind at MSY or BVE is east of 180°, then no stratus ceiling will occur at CBM.

b. If a strong trough exists 300-500 miles west of the station, expect stratus in the morning to cumulus in the afternoon. If the trough is weak, stratus is possible but will scatter by mid-morning.

KEESLER AFB (BIX) FORECAST GUIDE

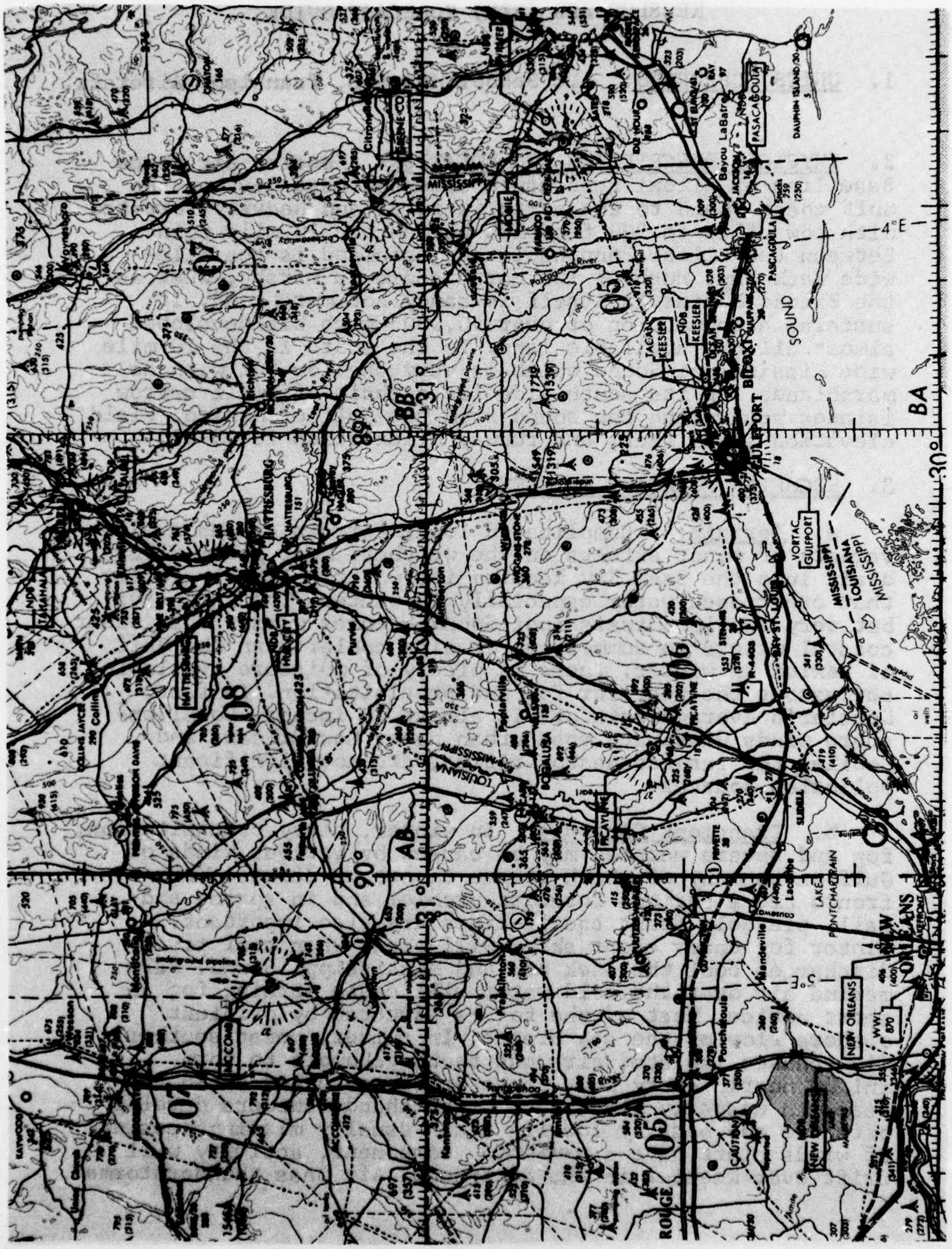
1. UNITS SUPPORTED: ATC School Mission, Transient Aircraft.

2. PHYSICAL DESCRIPTION AND LOCATION: Keesler Air Force Base lies on Biloxi Pennninsula oriented east-west on the Gulf coast. Land to the north is rural and heavily forested with low hills to 300 feet MSL beyond the 10 mile point. Between the Biloxi Penninsula and mainland is the mile-wide Back Bay. Much of its north shore is marshy, whereas the Biloxi Peninsula itself is sandy not marshland. It sustains a population of over 50,000 which has developed almost all the available land. To the south is the 10 mile wide Mississippi Sound which is very shallow but with no marshlands. On its south side lie a chain of small narrow islands separating the sound from the Gulf of Mexico. Field elevation is 35 feet, and runway orientation is 03-21.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Complicated local terrain causes a wide variety of minor effects on the weather. Most local rivers drain into the Back Bay keeping its waters slightly cooler than other open water especially in winter. The extensive but very shallow Mississippi Sound becomes warmer than other coastal waters in summer but remains cooler than the Gulf of Mexico in winter. There is plenty of moisture available throughout the year for fog and precipitation. In fact, Keesler's average rainfall is almost 60 inches. Local on-shore winds dissipate most urban haze. New Orleans and Mobile, the largest nearby cities, are not significant pollution sources.

b. Transient Controls: In winter, heavy precipitation, fog and severe weather may be caused by various kinds of Gulf waves many of which become important storms. Warm fronts are a serious forecast problem and in spring and fall, pre-cold front squall-lines are also important. Winter fog under clear skies will occur when cool river discharges cool the Back Bay and Mississippi Sound. Warm marine air oves the cold water will cause morning fog on short notice. Most of the fog is advected by gradient onshore flow or the sea breeze. In summer, moist southerly flow causes isolated air mass thundershowers to form inland nearly every day. These drift north and avoid the base. In easterly flow, late night thundershowers develop offshore and pass by locally again usually missing Keesler. If winds aloft have a northerly component, activity will drift over Keesler in the afternoon. Air mass thunderstorms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LOUISIANA
PICAYUNE
SLIDELL
Mandeville
LAKE PONTCHARTRAIN
NEW ORLEANS
VORTAC GULFPORT
DAUPHIN ISLAND
BA
BB
AB
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produce only heavy showers and lightning. Infrequent slow-moving cold fronts may approach from the north and trigger squall-lines that move in during late afternoon and evening hours. Moderately high winds sometimes occur. Tropical cyclones are infrequent visitors, though easterly waves occur every summer producing rain and ceilings.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type A: Weak trailing cold fronts from the Alberta Low usually do not pass Keesler but dissipate north of the station. Clouds, if any, will be category D on the front for a short period.

b. Type B: Cold fronts with this pattern may reach the coast and wave on occasion. A wave may develop on the front in the Gulf but will move east toward Florida and not affect Keesler. Category D middle clouds and some lower cloud will accompany the front.

c. Type B_1: With this type, a B pattern breaks down, and a wave forms out in the Gulf. Unlike the stable Type B wave, this one is unstable . As the low nears the Florida Panhandle, expect category D altostratus which lowers quickly to C or B clouds in steady precipitation. Visibility is also restricted around the wave crest and north of the low center.

d. Type C: Southerly flow may be strong at times. Stagnation may set in. Some stratocumulus and haze is possible. Temperatures are well above normal for winter.

e. Type D: Cold front will pass Keesler but is usually sluggish. Thunderstorms may organize into a squall-line ahead of the cold front. In the absence of squall-line, expect some layered ceilings and light showers.

f. Type E: Panhandle lows push cold fronts through Keesler and look just like Type B_2. Treat like the Type D pattern above. The Gulf low is another story entirely.

(1) Warm front: The low center will pass northwest of Keesler. As the warm front develops to the southwest, ceilings begin at D but deteriorate to B rapidly with C category visibility in fog, moderate rain and embedded thunderstorms. Severe weather in the form of high winds and offshore waterspouts may occur. Except for C category backwash behind the cold front, ceilings rapidly improve after the precipitation stops (low reaches Tennessee).

(2) Anticyclone weather: Polar outbreaks move so far south that when the high center moves to the east,

return flow is likely to move over chilled ground and water causing category B advection/radiation fog.

g. Type E_s: Gulf waves develop readily with this upper air pattern. Any upper level trough moving over El Paso and continuing east will generate a wave which looks like a Type B wave. Some middle clouds will occur at Keesler unless the development is very rapid (unlikely). Track of the wave is toward Florida.

SUMMER

a. Type B: This pattern is characterized by warm humid weather and air mass thunderstorms inland during the afternoon and offshore at night. Thunderstorms do not affect Keesler so long as winds aloft retain a southerly component. Avoid forecasting a ceiling unless tropical activity, such as an easterly wave, causes widespread rain and category D ceilings.

b. Type E: Fronts from the northwest may increase the coverage of thunderstorms in the local area. Change in air mass markedly improves the visibility and reduces cloud cover.

5. SEASONAL FORECAST RULES:

WINTER

a. Fog will not form with northerly surface winds.

b. Heavy morning radiation-advection fog may clear out at noon, but a reinforcement of onshore flow in mid-afternoon will bring the fog in again. Forecast category A or B.

c. Any stationary front in the Gulf will cause category B or C fog at night and in the morning at all points to the nearby north. Isolated thundershowers may develop on the front.

SUMMER

a. With 10,000 foot flow which has a southerly component, do not forecast a ceiling or thunderstorms. The one exception is when activity moves in from the southwest ahead of fronts in the spring.

b. With northeast 10,000 foot winds, mid-afternoon thunderstorms reach Keesler but bring no prolonged ceilings.

c. Late night offshore thunderstorms avoid land, but the high category D ceilings may reach Keesler.

MAXWELL AFB (MXF) FORECAST GUIDE

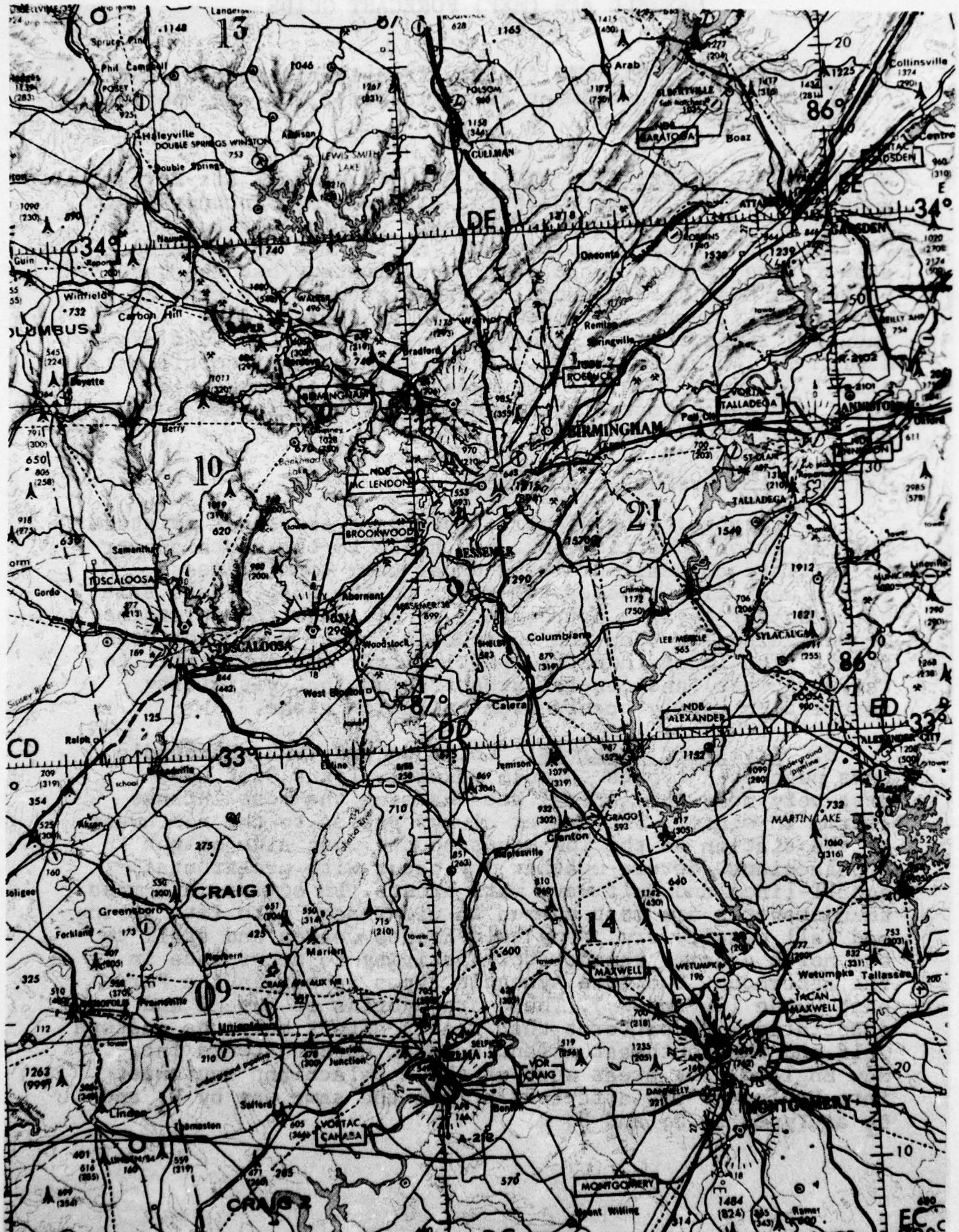
1. UNITS SUPPORTED: MAS (T-39), Transient Aircraft, AFRES (C-7). Additional amendment criteria are 2,000 and 500 feet; 1 and 3/4 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Maxwell Air Force Base is located in south central Alabama just northwest of Montgomery. Maxwell lies in the very shallow Alabama River Valley which flows by just to the north. The surrounding countryside is wooded and partly cultivated, but the base proper is nearly surrounded by urbanization. The city of Montgomery is east and south, while scattered light industry rings the west and northwest sides. The Gulf of Mexico is 140 miles south, and the Appalachian foothills rise 2,000 feet 80 miles northeast. Field elevation is 169 feet. The primary instrument runway is oriented 14-32, and the alternate is 18-36.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The Alabama River is a source of moisture for radiation-advection fog. Low hills to the north appear to initiate cold air drainage under calm conditions so that a weak flow crosses the river to the base. These same hills appear to have a frequency of air mass thunderstorms higher in summer than the surrounding area. Pollution does result from local industry (particularly one paper mill to the northwest) and general urbanization, but visibility restriction rarely occurs from pollution alone.

b. Transient Controls: Colorado and Texas Panhandle Lows push cold fronts through Maxwell. Texas Gulf Lows pass very near the general area causing the most intense storms in winter. The center always passes to the northwest of the station as the low heads up the west side of the Appalachians. Severe weather may occur with pre-frontal squall-lines and Gulf wave warm fronts. In summer, air mass thunderstorms are most common in mid-season with late spring and fall usually dry. Many cold fronts weaken and stall to the north causing thunderstorm activity to occur late in the afternoon. Two more synoptic types appear in the Forecast Guide (B_1 and B_2). These are hybrids of Type B and are associated with patterns that really affect only the eastern Gulf and the southeast Atlantic coast northeastward into New England. The areas west of the Appalachians southwest into Louisiana are affected in much the same way by B_1 and B_2 as Types B, D, and E.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Phil Campbell
Haleyville
DOUBLE SPRINGS WINSTON
Double Springs
LEWIS SMITH LAKE
CULLMAN
Arab
Boaz
Collinsville
86°
DE
34°
Oneonta
GADSDEN
Winfield
Carbon Hill
Fayette
Bradford
BIRMINGHAM
Springville
TALLADEGA
10
NDB
MC LENDON
BROOKWOOD
BESSEMER
21
TALLADEGA
TUSCALOOSA
Gordo
Columbiana
Chelsea
LEE MERRILLE
SYLACAUGA
Woodstock
West Blocton
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NDB
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Jemison
ALEXANDER CITY
Clanton
MARTIN LAKE
CRAIG 1
Greensboro
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Marion
14
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Thomaston
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MONTGOMERY
CRAIG 2
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4. **SYNOPTIC TYPES AND FORECAST RULES:** See Synoptic Type Discussion in the Introduction.

a. Type A: Weak cold fronts drift occasionally into the Maxwell area as this polar outbreak passes through the Ohio Valley. Some category D middle clouds and scattered cumulus mark the front. Late in the winter season, thunderstorms may occur south of the front.

b. Type B: Though surface pressures are higher that in the case of Type B, fronts are still more likely to pass through the area. Stagnating anticyclones will generate haze. Gulf waves occasionally develop and move through Florida or southern Georgia and affect Maxwell. (See Type B_1 below). If highs stagnate, category D visibility in haze and smoke will exist in the early morning.

c. Type B_1: Known as the Hatteras Low type, it differs from stable B type Gulf waves or Type E Gulf waves in that it is unstable. It usually hangs up in the Macon, Georgia area and reforms near Hatteras into a deep low. Expect increasing category D middle cloud decreasing to low C category as rain begins. Precipitation tends to end once the low reforms in the Atlantic, but the clouds hang around until it is well up the East Coast or until east of 70°W.

d. Type B_2: This is known as the Panhandle stable wave because it occurs in a slow zonal but split flow as systems pass under a major surface ridge over the northern Mississippi Valley. This type is very common and although usually "stable", may develop further off the Atlantic coast and tend to recurve. In any case, a short period of low ceilings will occur at MXF if the low center is north of the station. If the center is over or south of MXF, the period of low ceilings may be 24 hours long. In late winter, a squall-line may precede the cold front.

e. Type C: High pressure extends over the Southeast, and temperatures are unseasonably warm. Stagnating conditions may persist for days. Unlike stations in the western Gulf states, strong southerly inflow is unlikely. As a result, haze is likely.

f. Type D: Cold fronts move in from the northwest but become sluggish at this latitude and this far east (Low center moves into the Great Lakes). Some may even dissipate before reaching Maxwell.

(1) Cold Front: Active cold fronts may provide a variety of weather depending on strength. A wide band of cloud and precipitation may occur along with a possible squall-line and C category stratocumulus. The other extreme should be treated like Type A, B or B_2.

g. Type E: Texas Panhandle lows may be treated like the Type D or B_2 case. More emphasis must be placed on the following arctic outbreak than Type D as it is moderate with this case. Texas Gulf lows pass close to the station but always stay to the northwest of the station and exposing MXF to classical warm-frontal overrunning.

(1) Warm Front: Category D stratocumulus and altocumulus precede the warm front, and ceilings lower to C as the low begins to come onshore in Louisiana. Clouds lower further to category B when moderate precipitation and fog develop with the approaching front. Thunderstorms, with some severe, may also occur along the front. Rapid improvement occurs as the warm front moves to the north of the station.

(2) Warm Sector: Watch out for a squall-line in the warm sector especially near the approaching cold front. Some category C or D stratocumulus will occur in the southerly flow.

(3) Cold Fronts: Generally treat like a Type D. The exception is a rapidly developing low which moves very slowly up the west side of the Appalachians. In that case, hold backwash stratus in for 6-18 more hours after frontal passage.

h. Type E_s: Gulf waves form most readily with this synoptic types. Their movement is more zonal. Middle cloud ceilings, occasional C category ceilings and light precipitation will occur at MXF as they move on to the east.

SUMMER

a. Type B: The Bermuda High is strong over the Southeast so that southeast flow prevails aloft as well as on the surface. Air mass thunderstorms may affect Maxwell at any time of the afternoon, but ceilings are uncommon.

b. Type E: Fronts moving from the northwest may cause squall-line activity to enter the area. Most severe reports are high winds associated with afternoon and evening activity

5. SEASONAL FORECAST RULES: None.

CRAIG AFB (SEM) FORECAST GUIDE

1. UNITS SUPPORTED: 29th Flying Training Wing (T-37, T-38). Flying training ceases if conditions are ever less than 600 feet and/or two miles, if icing exists to any degree and if cross winds exceed 10 knots.

2. PHYSICAL DESCRIPTION AND LOCATION: Craig Air Force Base is located in south central Alabama 5 miles northeast of Selma and 30 miles west-southwest of Montgomery and Maxwell AFB (MXF). The local terrain is low and rolling with woods and limited cultivation. Craig is bounded on three sides by the Alabama River. About 25 miles north, elevations begin to rise into the Appalachian foothills, as much as 2,000 feet beyond 75 miles. The Gulf of Mexico is 140 miles south. Field elevation is 166 feet. The dual runway complex is oriented 14-32.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The Alabama River is a source of local moisture for advection-radiation fog. The main problem is smoke pollution from a ferrosilion plant two miles north and a pulp mill 9 miles northeast of Craig. After their establishment in the mid-60's, visibility restrictions have increased greatly reducing the scope of pilot training operations. Category C conditions occur at sunrise whenever there is stagnation, and category D may occur at all other hours. Conditions are usually worst a short distance aloft. In summer, category D visibility is typical in the morning with north winds, but the prevailing southerly flow about the Bermuda High diminishes this hazard.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Maxwell Forecast Guide.

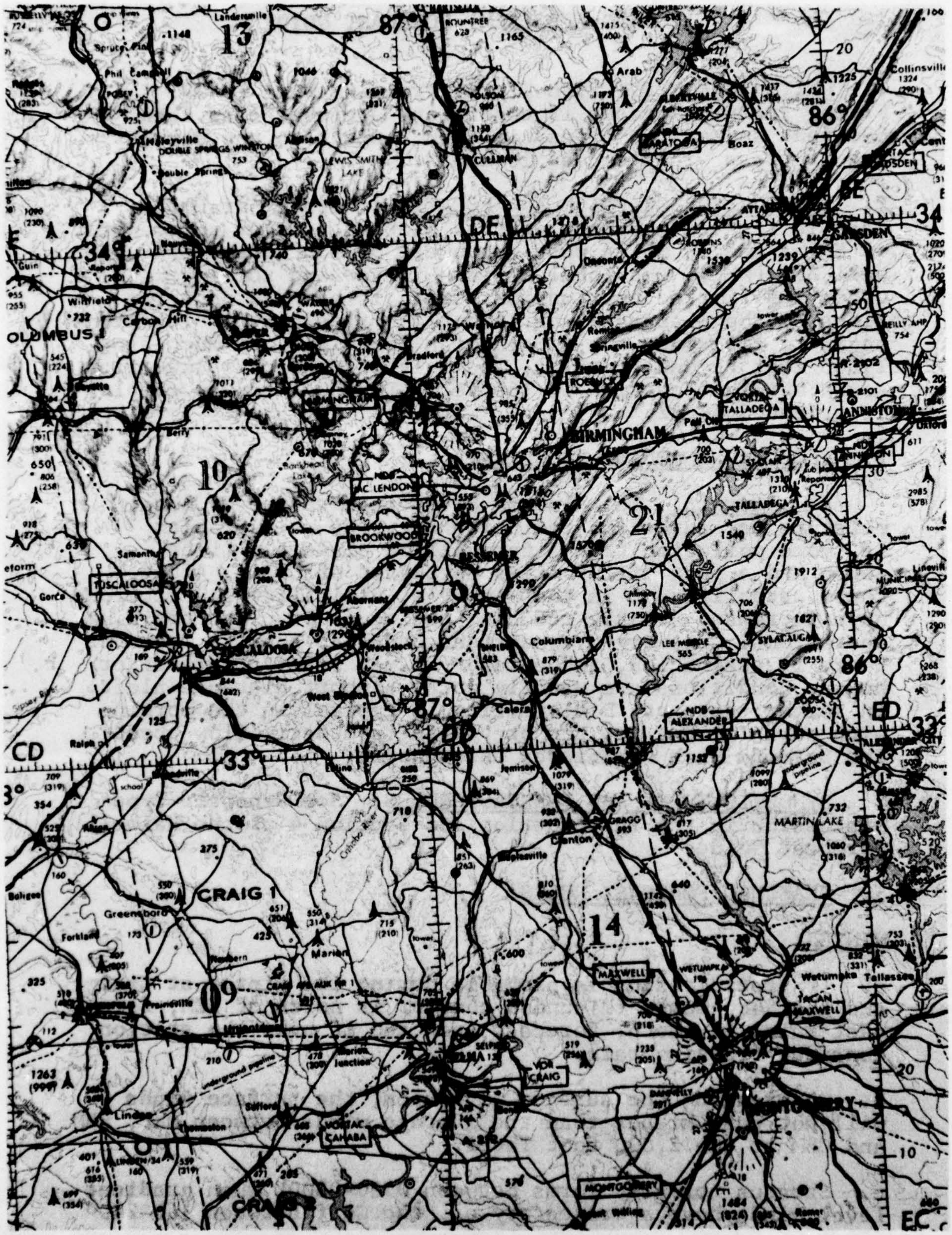
5. SEASONAL FORECAST RULES:

WINTER:

a. If precipitation is probable during the winter at Craig, and the 5460 meter thickness contour is north of SEM, forecast rain. If south, forecast snow and if over the station, consider freezing rain.

b. On breaking the surface inversion, the surface winds will not gust higher than the average winds between MXF, BHM and CBM at the 2,000 foot level.

c. Stratus normally forms between 0500-0800L when gradient level winds have a trajectory off the Gulf between 160-240°



13
87°
CULLMAN
Arab
Boaz
86°
Collinsville
GADSDEN
DE
34°
COLUMBUS
10
BIRMINGHAM
21
TALLADEGA
ANNISTON
BROOKWOOD
BESSEMER
TUSCALOOSA
Columbiana
SYLACAUGA
CD
33°
ALEXANDER
ED
MARTIN LAKE
CRAIG 1
Greensboro
14
MAXWELL
Wetumpka
Tallassee
09
SELMA
MONTGOMERY
EC

along with significant moisture advection during the past 18-24 hours.

d. A half hour to one hour usually elapses between the first wisps of stratus and the formation of a sufficient amount to constitute a ceiling.

e. Gradual clearing can be expected after a 500 mb trough passes BAD.

f. A quick break in the surface inversion will normally stop Gulf stratus south of Craig.

g. Determine thickness in hundreds of feet of Atlantic or Gulf stratus throughout the area. Multiply this by .3. This will give you the number of hours in which stratus should break with clear skies above.

SUMMER

a. During the summer, surface winds will shift to blow from thunderstorm activity. After the thunderstorm moves out of the area (usually about 15 miles), the winds will return to their original direction.

b. Squall-line thunderstorms frequently develop in areas of rising height at the 850 mb level.

c. Cumulus development between sunrise and 0800L will usually dissipate by 1000L; development 1000-1200L will normally build to thunderstorms by 1500L within 60 NMI and dissipate by evening; and development between 1200-1400 will build to thunderstorms by 1700L and usually persist until late evening.

ALL SEASONS

a. Ninety percent of all reported surface hail occurred when the wet bulb freezing level is between 5,000 and 12,000 feet with most of these clustered around 8,000 feet.

b. The optimum height of the wet-bulb zero is 8,000 feet. When the height is less than 5,000 or more than 11,000 feet, the incidence of surface hail and thunderstorm gusts is practically negligible. Tornadoes (if any) are relatively weak and short-lived except in an equatorial type air mass that is moist to great heights. Such stroms are common along the Gulf coast and produce the waterspouts so often reported over the coastal waters.

c. Hailstorms are rather infrequent in the Craig area, usually averaging less than once per year and more like once every five years.

d. Freezing precipitation usually lasts for only a short period of time and is light. It occurs on the average of less than once per winter and never reaches hazardous proportions in the Craig area.

e. Snowfall in the Craig area is important only as a curiosity averaging only 0.2 inches per year. Snow remains on the ground only for brief periods.

FORT RUCKER - CAIRNS AAF (OZR) FORECAST GUIDE

1. UNITS SUPPORTED:

2. PHYSICAL DESCRIPTION AND LOCATION: Fort Rucker is a Large Army complex in southeast Alabama near Cairns. The largest nearby city is Dothan 20 miles to the east-southeast. Montgomery is 90 miles northwest, yet Cairns has much in common with Maxwell Air Force Base climatology. The Gulf of Mexico is 75 miles southwest, a little too far to give Cairns a coastal climate. Local terrain is fairly flat, much of it wooded and the rest cultivated. The small Choctawhatchee River flows southward 3 miles to the east and is the only moisture source. Field elevation is 305 feet. The primary instrument runway is 06-24 with alternates 18-36 and 13-31.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Aside from the Gulf of Mexico, local moisture sources are unimportant. Air mass thunderstorms do form rather readily 10-20 miles north of the Gulf coast and drift north, but these usually dissipate well south of Cairns at sunset. As a result, the air mass activity resembles that at more northerly bases such as Maxwell and Craig. The absence of heavy industry minimizes pollution problems.

b. Transient Controls: See Maxwell Forecast Guide.

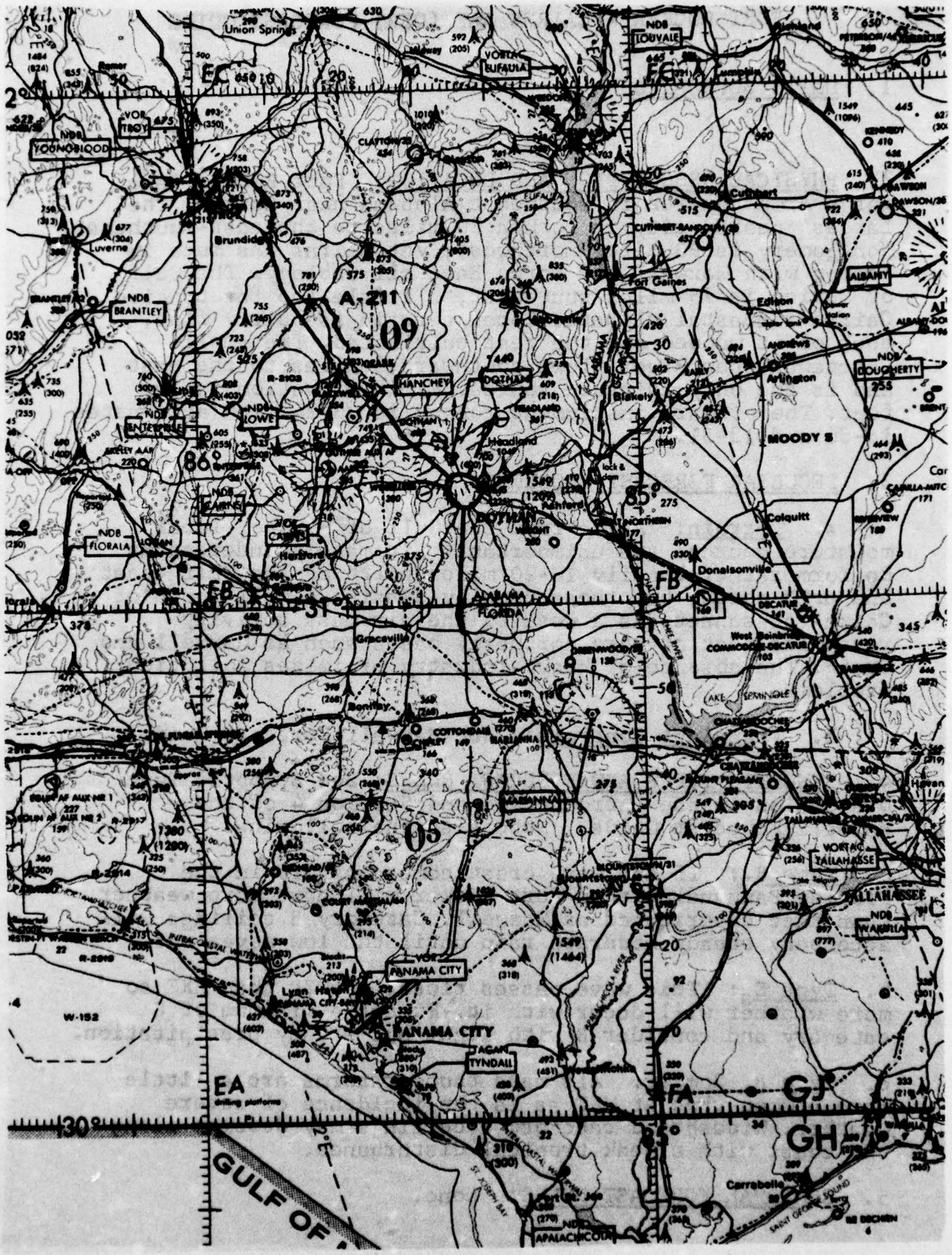
4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Maxwell Forecast Guide. Note also the following.

a. Type B_1: If the wave crest comes onshore in the Florida Panhandle, then Fort Rucker will have more weather than that experienced at Maxwell. Category B ceilings will accompany steady moderate rain until the low moves out.

b. Type E_s: This wave passes closer to OZR than MXF so more weather will occur with it. Expect a minimum of C category and consider B with light but steady precipitation.

c. Type B, Summer: Air mass thunderstorms are a little more common than at MXF as is the incidence of severe weather. Widespread category D ceilings may develop along the coast with a weak tropical disturbanee.

5. SEASONAL FORECAST RULES: None.



Union Springs
EUFAULA
LOUVALE
TROY
YOUNGBLOOD
Luverne
Brundidge
BRANTLEY
A-211
09
HANCHEY
DOTHAN
LOWE
ENTERPRISE
FLORALA
Cuthbert
Fort Gaines
ALBANY
Edison
Arlington
DOUGHERTY
MOODY 5
Blakely
Colquitt
Donalsonville
Graceville
Bonifay
MARIANNA
05
PANAMA CITY
Lynn Haven
TYNDALL
TALLAHASSEE
WAKULLA
Carrabelle
W-152
GULF OF

LAWSON AAF (FORT BENNING) LSF FORECAST GUIDE

1. UNITS SUPPORTED: US Infantry Center (T-41, T-42, U-8), (also U-21, C-45, AH-1, UH-1, CH-47, OH-58), Det 1, 317th TAW (C5A, C-7, C-123, C-130, C-141), 197th Infantry Brigade (UH-1, OH-58). Additional amendment criteria are 500 feet and/or 1 mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Lawson Army Airfield is in the southwest corner of the large Fort Benning Reservation in extreme west central Georgia. Fort Benning is on the south side of Columbus, Georgia which is 8 miles north of the field. The combined population of Columbus, Phenix City and suburbs is nearly 200,000. The Chattahoochee River, which separates Alabama and Georgia, flows southward past the west end of Lawson Field and acts as a good moisture source. Local terrain is low and rolling with some forests and cultivated land apart from the Columbus area. Low hills begin to appear 25 miles north, however, and elevations to 2,000 feet may be found beyond 50 miles north-northwest. The largest local body of water is Walter F. George Lake 20 miles to the south. The Gulf of Mexico is 190 miles south. Field elevation is 232 feet, and the instrument runway orientations are 14-32 and 02-20.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Lawson is most affected by the Chattahoochee River which is both close by and at the same elevation as the field. It definitely provides moisture for advection-radiation fog. The gradual rise in elevation to the north will create a mild upslope effect with southerly flow. Urban sources of pollution apparently present no undue visibility problem except under the influence of a stagnating high.

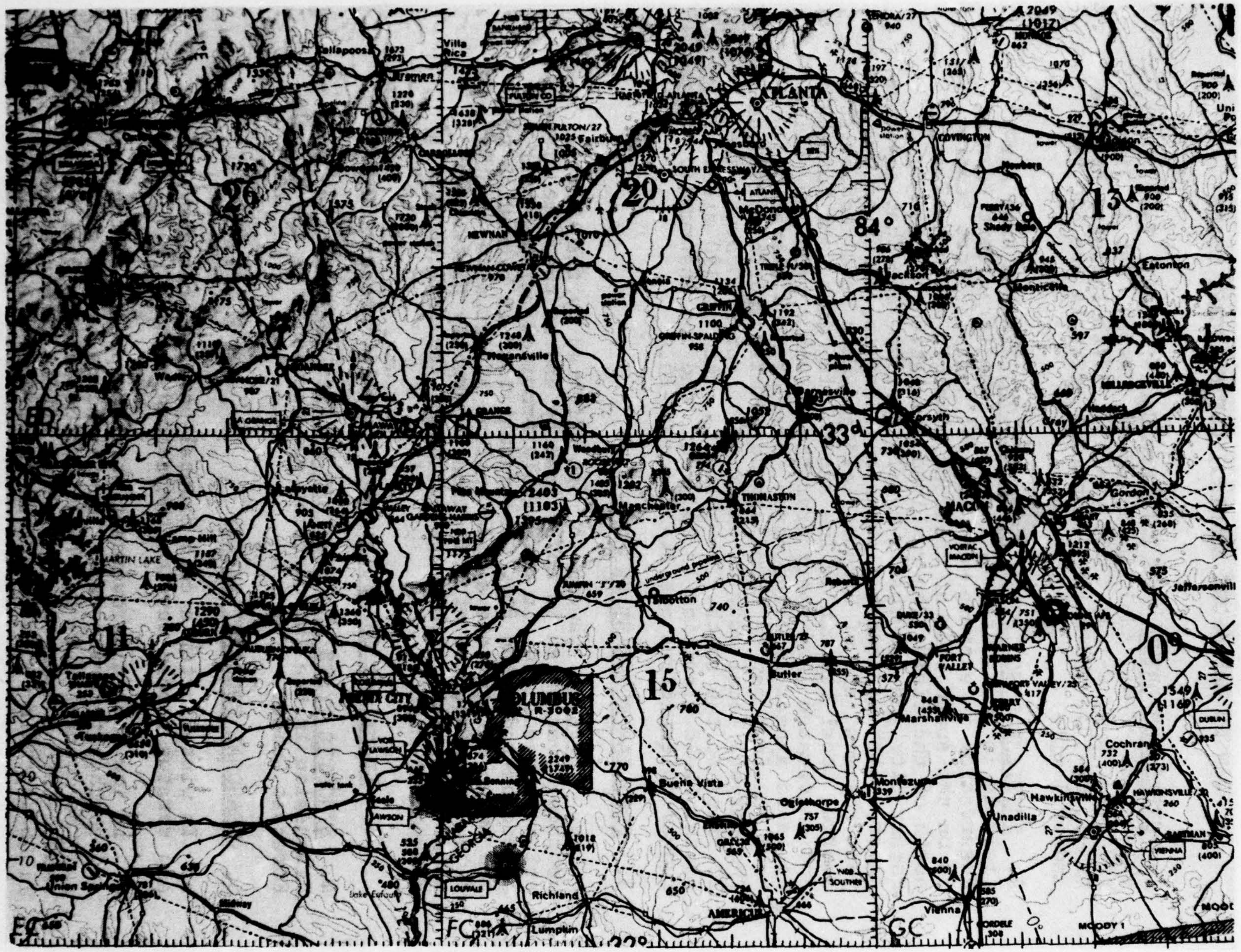
b. Transient Controls: See Maxwell Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Maxwell Forecast Guide.

5. SEASONAL FORECAST RULES:

a. In winter after a cold frontal passage, category B fog and stratus should develop the second morning.

b. If low broken or overcast stratus appears to the east and southeast during early morning hours in the summer and the general flow is 070-160°, the stratus will be advected into the Lawson area. Burn off is likely at 1000-1100L depending upon the cloud cover over the stratus.


ATLANTA
COVINGTON
NEWNAN
Jeffersonville
Cochran
Unadilla
Vienna
Butler
Buena Vista
Oglethorpe
Marshallville
Richland
Lumpkin
COLUMBUS
R-3002
MARTIN LAKE

EGLIN AFB (VPS) FORECAST GUIDE

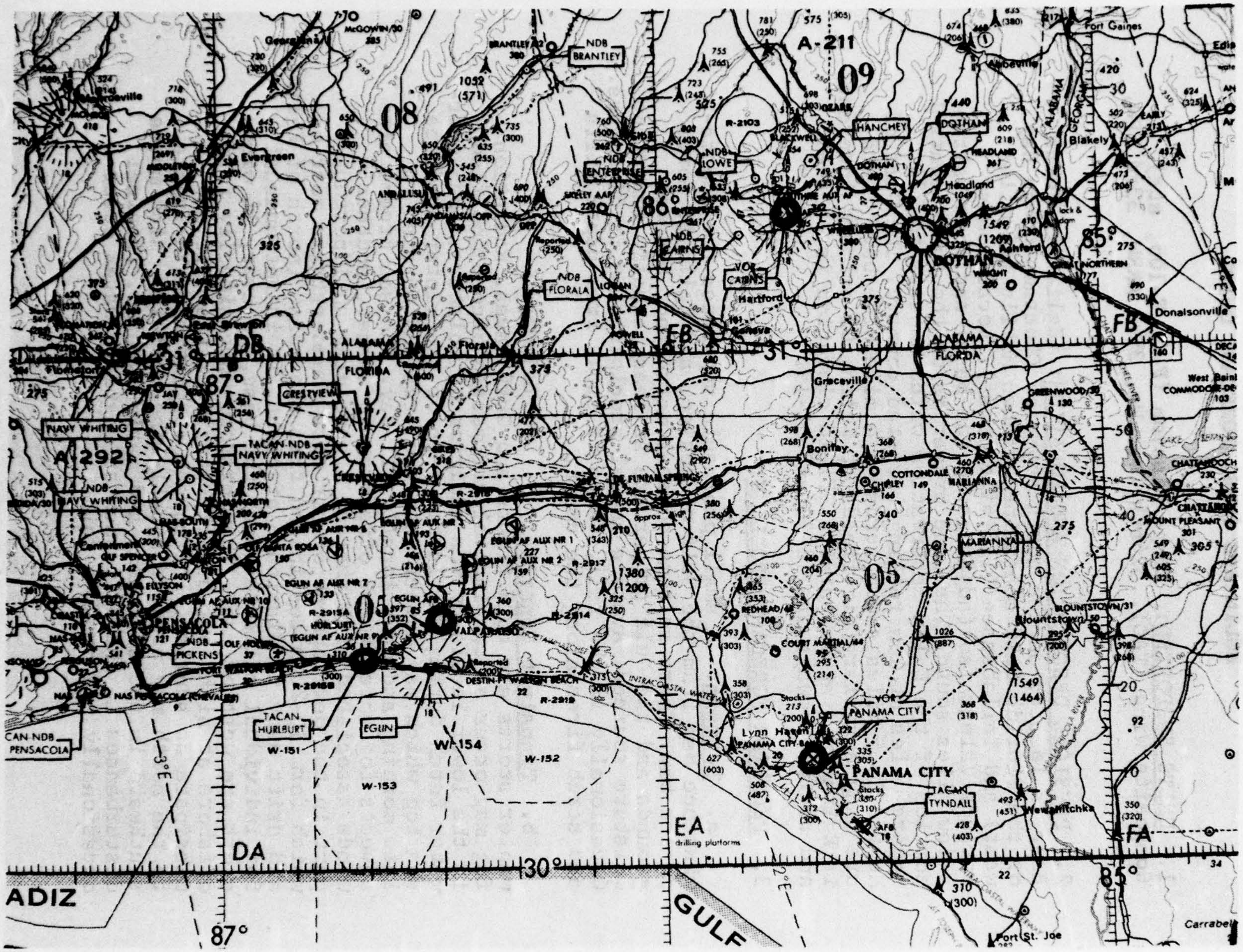
1. UNITS SUPPORTED: Range Mission (F-4, F-105, etc), Composite Wing (TAC). 3246th Test Wg, 39th ARRW, 33rd TFW.

2. PHYSICAL DESCRIPTION AND LOCATION: Eglin Air Force Base is located on the north shore of Choctawhatchee Bay on the Florida Gulf coastline between Mobile (83 miles west) and Tallahassee (115 miles east). Local towns include Valparaiso (adjacent to the base) and Fort Walton a few miles south. The base proper is on the south central portion of the Eglin Reservation which amounts to 725 square miles of low rolling forested country. The Gulf of Mexico is 5 miles south across a 4 mile wide bay. There are many auxiliary air fields at Eglin. Of primary interest is Eglin Main at Valparaiso. Field elevation is 85 feet, and active runways are 12-30 and 01-19.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: A small peninsula separates the Choctawhatchee Bay from the Gulf of Mexico, and Eglin is north of the bay. There is some coastal marshland, but wet grounds and the Gulf proper are at least equally important moisture sources. Average annual precipitation is 61 inches. Occasionally in the fall, there is smoke from paper mills and scrub fires along the coast.

b. Transient Controls: The majority of winter storms are cold fronts and Gulf waves. Radiation fog may occur as continental air masses become modified in the lower levels by the addition of moisture. Long over-water fetch during the latter part of the winter produces sea fog which may advect into the area and persist to late morning and occasionally all day. The sea breeze also advects fog which forms offshore. In summer, southerly winds associated with the sea breeze play an important part in the development of air mass thunderstorms most of which form 10-20 miles inland from the coast (north of Eglin) and drift away to dissipate at night. It is not unusual for individual cells to reach the base, however, if winds aloft are west or east. Thunderstorms occasionally form offshore at night but usually stay over the Gulf and dissipate at sunrise. Infrequent stagnating cold fronts to the north may produce squall-line activity which moves southward in the afternoon and early evening. Tropical disturbances in the Gulf such as easterly waves occur occasionally and produce rain.



PANAMA CITY
DOTHAN
MARIANNA
TYNDALL
HANCHEY
CAIRNS
ENTERPRISE
FLORALA
BRANTLEY
LOWE
CRESTVIEW
NAVY WHITING
EGLIN
HURLBURT
PENSACOLA
PICKENS
VALPARAISO
ALABAMA
FLORIDA
GEORGIA
GULF
ADIZ
A-211
A-292
W-151
W-152
W-153
W-154
87°
86°
85°
30°
31°

4. <u>SYNOPTIC TYPES AND FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction.

a. <u>Type A</u>: Cold fronts do not reach Eglin. Weak ridging dominates this part of the Gulf Coast.

b. <u>Type B</u>: Weak cold fronts pass the station. Waves in the Gulf on these fronts is common. Trajectory of waves is to the east across the Florida Peninsula except for Type B_1 below.

(1) <u>Cold Front</u>: Expect some D category stratocumulus with the front.

(2) <u>Gulf wave</u>: Category D middle clouds become C category as precipitation starts and continues for 6-12 hours. Rapid clearing takes place as the wave moves off the east coast of Florida. Some thunderstorms may accompany the wave.

c. <u>Type B_1</u>: This degeneration of the Type B pattern produces a Gulf Wave which turns into a major East Coast storm. The polar outbreak that follows it is moderate with the cold front going all the way to the Florida Keys. The developing cyclone passes north of Eglin, so warm front overrunning occurs at the base until the low gets into southern Georgia. Weather deteriorates rapidly to B category ceilings on the front with C visibility in moderate rain and fog. Severe weather may occur also along the warm front boundary. Slow clearing at all levels begins as the warm front passes by. With passage of the cold front, category C ceilings are likely again for a short while along with thunderstorm activity (if there is any moisture left in depth).

d. <u>Type C</u>: Moderate southerly flow. Unseasonably warm temperatures. Periods of category D cumulus and haze are likely. Regime may last for weeks.

d. <u>Type D</u>: Cold fronts become very sluggish this far south and east. They may get hung up before ever reaching Eglin. Expect about 6 hours of category C or D stratocumulus with the front and possible thundershowers. If any wave action appears on the front, treat like a type B.

e. <u>Type E</u>: The Texas Panhandle Low will push a cold front down to Eglin, but it will kick off some thunderstorms and little else. Treat like a Type D cold front. The Gulf low is another story entirely. A moderate cold front will pass Eglin with a moderate polar outbreak behind it. Because of the orientation of the Gulf low, warm front overrunning will occur at Eglin. It will last about half as long as Type B_1.

f. <u>Type E_s</u>: Gulf waves form readily and move eastward to Florida. Treat like waves of Type B.

SUMMER

a. Type B: Bermuda Ridge is established with southeasterly flow aloft. Isolated thunderstorms tend to avoid Eglin Main. Northern parts of the reservation are affected. Low category D ceilings and steady rain with embedded thunderstorms are general along the coast when an easterly wave moves through the area.

b. Type E: Fronts from the northwest may not make it past Eglin. If they do, thunderstorm coverage is greater.

5. SEASONAL FORECAST RULES:

a. Winter: Stratus and fog in return flow about the rear of an anticyclone are likely if dewpoints are 60°F in the daytime, 50° or more at night.

b. Summer: Air mass thunderstorms require moisture up to at least 700 mb to develop. Spreads less than 15°C are necessary.

HURLBURT FIELD (HRT) FORECAST GUIDE

1. UNITS SUPPORTED: 1st SOW (C-130E, C-130H, OV-10, O-2A).

2. PHYSICAL DESCRIPTION AND LOCATION: Hurlburt Field is located on the Gulf coast on the southwest side of the Eglin Reservation about 15 miles southwest of Eglin Main and 5 miles west of Fort Walton Beach, Florida. A very narrow sound lies between Hurlburt and the Gulf of Mexico with Santa Rosa Island in between. Thus the field is a little over a mile north of the Gulf. Hurlburt is also on the south side of the East Bay Swamp. Field elevation is 35 feet, and runway orientation is 17-35.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Swampy local terrain and the base's close proximity to the Gulf usually means more fog than at Eglin which is further north and higher. On the other hand, air mass thunderstorms usually form 10 miles north of Hurlburt and are less likely to affect the field. Nocturnal storms, however, may drift onshore at sunrise. As in the case of Eglin, pollution is not normally a forecast problem.

b. Transient Controls: See Eglin Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Eglin Forecast Guide.

5. SEASONAL FORECAST RULES: See Eglin Forecast Guide.

VORTAC MONROEVILLE
Frisco City
Evergreen
Luverne
Brundidge
NDB BRANTLEY
NDB LOWE
NDB FLORALA
08
08
04
DB
EB
31°
87°
CRESTVIEW
FLORIDA
ALABAMA
NAVY WHITING
292
TACAN-NDB NAVY WHITING
NDB NAVY WHITING
PENSACOLA
NDB PICKENS
TACAN-NDB NAVY PENSACOLA
TACAN HURLBURT
EGLIN
W-151
W-153
W-154
W-152
DA
EA
drilling platforms
30°
30°
STAL
ADIZ
87°
W-155
GULF OF ME

TYNDALL AFB (PAM) FORECAST GUIDE

1. UNITS SUPPORTED: ADC (2nd TAC FTR Int Trng Sq), 475th Test Sq (FIS Training), Air Defense Weapons Center.

2. PHYSICAL DESCRIPTION AND LOCATION: Tyndall Air Force Base is located on a peninsula on the Gulf coast eight miles southeast of Panama City, Florida. East St. Andrew Bay, about 4 miles wide, separates the nearly equally large peninsula from the mainland. Surrounding country is flat, marshy and wooded. Panama City, the only large urban area, is on the mainland. Field elevation is 17 feet. The instrument runway is oriented 13-31.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The relatively dry and sandy peninsula on which Tyndall lies inhibits ground fog. In winter, however, cold river discharge into the bay and cooled marshes aid in the generation of radiation/advection fog when moist marine air is drawn in. Air mass thunderstorms build on the mainland north and east of Tyndall in summer. The annual precipitation of 55 inches is somewhat lower than other stations on the Gulf Coast. The only pollution source locally is a paper mill five miles northwest in Panama City. Light winds from 330° under stable conditions may lower visibility to category B in the early morning.

b. Transient Controls: See the Eglin Forecast Guide. The northwest-southeast orientation of the coastline complicates the summer air mass thunderstorm pattern. An east-northeast flow aloft should increase the chances of afternoon thunderstorms. Offshore thunderstorms late at night should remain offshore.

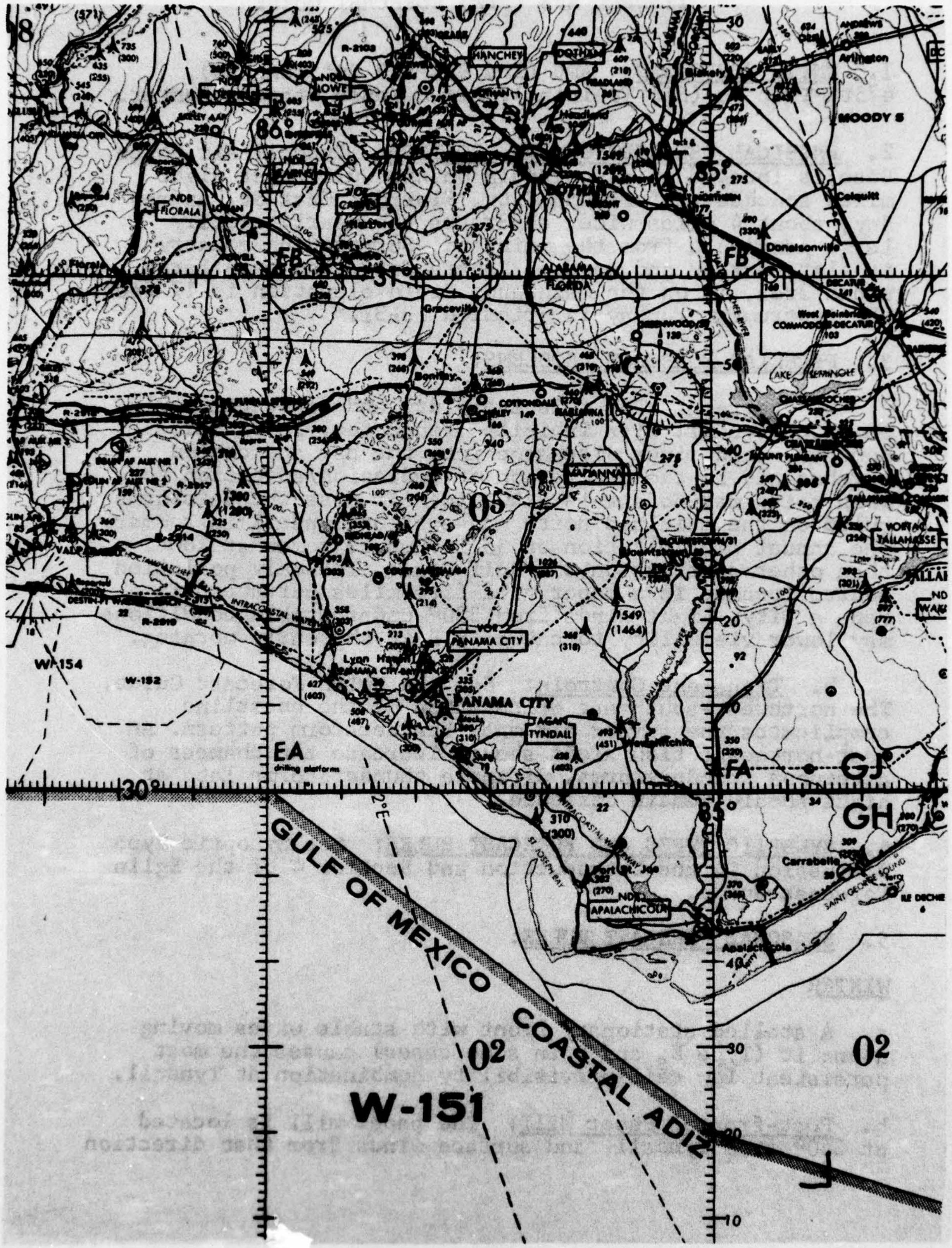
4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Eglin Forecast Guide.

5. SEASONAL FORECAST RULES:

WINTER

a. A stalled stationary front with stable waves moving along it (Type E_s and B in some cases) causes the most persistent low ceiling/visibility combination at Tyndall.

b. Post-frontal Paper Mill: The paper mill is located at 340° from Tyndall, and surface winds from that direction


GULF OF MEXICO COASTAL ADIZ
W-151
W-154
W-152
PANAMA CITY
TYNDALL
APALACHICOLA
MARIANNA
TALLAHASSEE
DOTHAN
FLORALA
Donalsonville
Colquitt
Arlington
Blakely
MOODY 5
Graceville
Bonifay
Lynn Haven
Carrabelle
EA
FA
FB
GJ
GH
drilling platforms
30°
86°
85°
0²
05
ALABAMA
FLORIDA
ST JOSEPH BAY
ST GEORGE SOUND
INTRACOASTAL WATERWAY
APALACHICOLA RIVER
Apalachicola
1549
(1464)

produce visibility restrictions. This wind direction is particularly common about mid-morning after a frontal passage. Light surface winds and a strong low level inversion are present when the lowest visibility is experienced (B). Note: Mixtures of smoke and radiation fog may result in even lower conditions.

c. Gulf Coast Stratus: In general, stratus results from southeasterly to southerly winds pumping in moisture over the relatively cold northern Gulf and rapidly cooling upon approaching land. Mornings are the favored formation time (early) since winds are light and the temperatures are minimum. Dissipation time depends on cloud cover above and thickness of the stratus layer. In general, dissipation rate will be 500 ft/hr (no cloud cover above) beginning about 1½ hours after sunrise.

d. Sea Fog: This fog is frequent and will take PAM below minimums in a few minutes and keep the base down for hours. With fairly strong winds from almost due south when a stagnant high puts PAM on the back side with return flow, this fog is likely. The flow must be maintained for more than a day so that an excess of moisture is present. Some forecasters claim that 69°F is the critical temperature to watch. When a drop below this temperature occurs coupled with a dewpoint spread less than 3°F and a fog bank present over the Gulf, fog will reach the base. Common occurrence time is 1 to 2 hours prior to sunset, and it is never certain that the fog bank will reach the runway (quite often it remains thin and offshore).

e. Northeast Syndrome Stratus: The slow progression of a high into the southeast U.S. following frontal or trough passage will generally cause widespread stratus. The slower the movement, the greater the potential. Watch for wind shifts (surface and gradient) into the northeast quadrant. The first real indications will come from surface observations from JAC, SVN, NEA. If it progresses inland to VAD, NAB, and TLH, look for stratus at PAM a few hours later. This type of stratus also likes to sneak up on the forecaster sometime after midnight. Many times the system does not stagnate long enough to affect PAM with anything more than scattered conditions. However, if the stagnation continues, it is almost certain to give broken to overcast conditions the next night. Daytime dissipation does not occur as rapidly as expected, and if the situation persists, the stratus is thicker each day.

f. Gulf Waves: If a stalled front in the Gulf indicates a tendency to wave and low clouds and rain begin on the

Texas coast, the indicator station is NBG. Watch NBG closely for clouds and rain. It is generally accepted , though not always true, that NBG + 12 hours is PAM weather with the upper difference 18 hours. It is also a general rule that VPS + 2 hours equals PAM weather. (TYPE E).

SUMMER

a. Thunderstorms develop north and northeast of Tyndall early in the afternoon about 10 miles inland. They tend to avoid the base but with east or west winds having any northerly component, activity is much more likely later in the day.

b. The sea breeze vector for PAM is 220-240° and has a velocity of 8-12 knots depending on the extremes of temperature. While generally a summer phenomenon, the sea breeze may occur in any month.

c. The resultant of the surface wind produced by the synoptic pattern and the sea breeze vector will normally give an accurate afternoon wind forecast. Maximum gusts due to this effect will normally occur 1-2 hours after onset of the sea breeze.

REGION 14

SOUTH ATLANTIC COAST AND FLORIDA

FORECAST GUIDES

Pope AFB	POB
Seymour-Johnson AFB	GSB
Shaw AFB	SSC
Myrtle Beach AFB	MYR
Fort Stewart - Wright AAF	LHW
Moody AFB	VAD
Robbins AFB	WRB
Dobbins AFB	MGE
MACDILL AFB	MCF
Patrick AFB	COF
Homestead AFB	HST

POPE AFB (POB) FORECAST GUIDE

1. UNITS SUPPORTED: 317th TAW (C-130), 1st AMEW.

2. PHYSICAL DESCRIPTION AND LOCATION: Pope Air Force Base is located in central North Carolina 9 miles northwest of Fayetteville. The base is in the northeast corner of the Fort Bragg Military Reservation two miles from the main post area. The Atlantic Ocean lies east through south of Pope, its nearest point being just under 100 miles southeast. There is a general slight rise in terrain from the ocean to the Appalachians which are more than 125 miles west and northwest of the base, but in general the land is low and slightly hilly. Field elevation is 218 feet, and the runway is oriented 04-22.

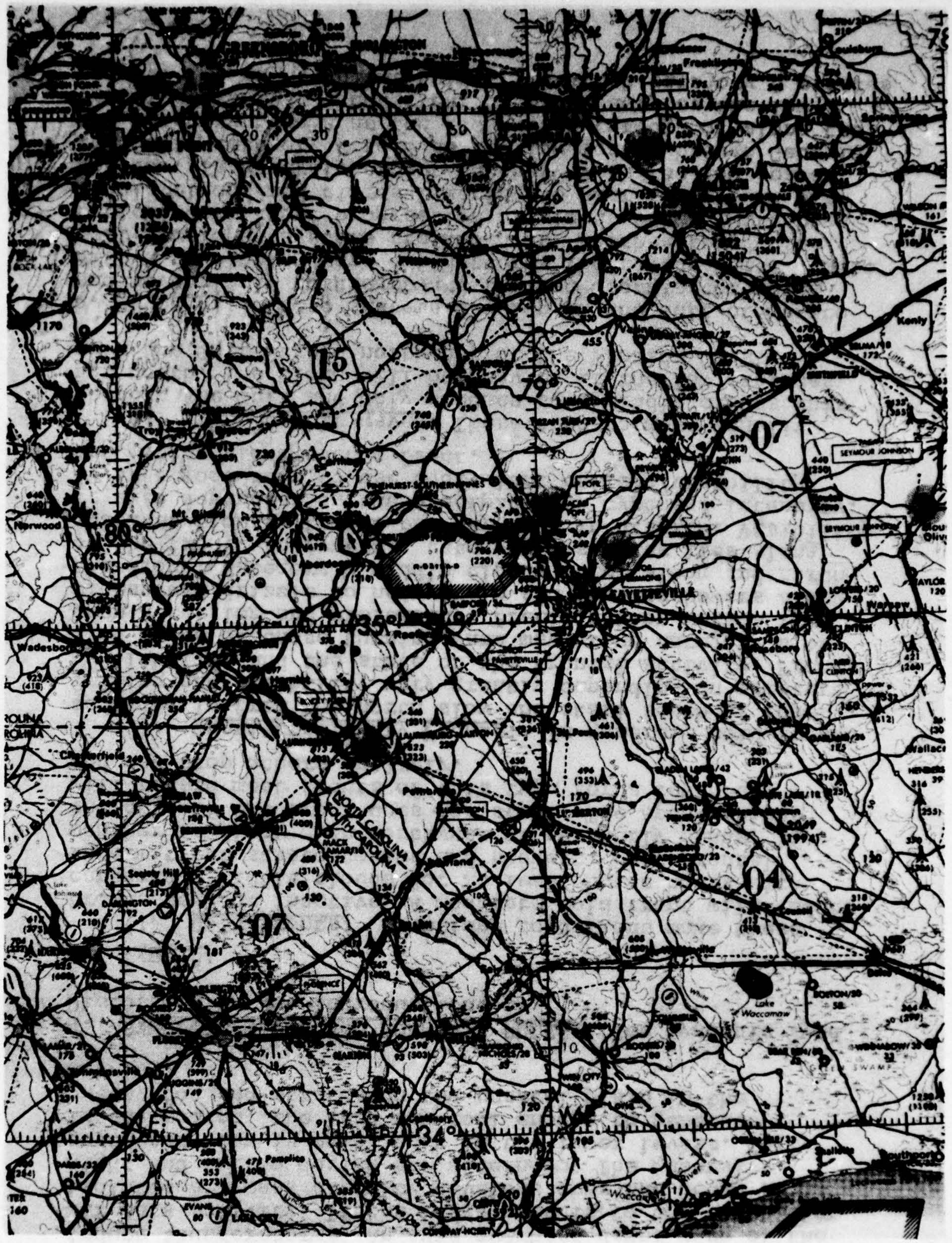
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Local terrain is low and rolling country with upslope from northeast through east to south-southwest, and downslope moving from the northwest to the base. The land is heavily forested with many small lakes and streams which contribute in a small way to area moisture which is primarily advected in from the Atlantic. There are no nearby land features of particular concern.

Pollution from Fort Bragg is an occasional fall and winter forecast problem. Near dawn, a south or east wind may bring in smoke under a low inversion. There is no danger of pollution affecting the base in westerly flow. Restriction can be as low as category C near sunrise.

b. Transient Controls: Winter cold fronts are usually weakened by downslope if they approach from the west or northwest. All fronts become a problem if they stall and become quasi-stationary. In summer, cold fronts may follow behind moderate squall-lines. Quasi-stationary or warm fronts tend to produce prolonged conditions of low ceiling and visibility along with steady precipitation. Anticyclones to the north produce a winter type wind field from the northeast that may produce stratus and fog. Necessary ingredients include a trajectory over the Atlantic (from the direction of the Gulf Stream) and cooling induced by land and upslope towards the west (Appalachians). Quasi-stationary cold fronts, when south, intensify the stratus still more, and developing waves may add strong low-level winds.

In summer, stagnating highs bring enough haze to reduce visibility to category D in the morning and at night. Visibility aloft may remain low up to 5,000 feet at all times and persist for days. The Bermuda Ridge axis is of particular importance to summer forecasting. If the ridge is south of a station, fronts may move in from the north and


SEYMOUR JOHNSON
FAYETTEVILLE
NORTH CAROLINA
SOUTH CAROLINA
Lake Waccamaw
Norwood
Wadesboro
Kenly
Southport
Pamplico
SWAMP
07
04
15
35
34

induce thunderstorms. An axis overhead damps much of the air mass activity. If the ridge axis is to the north, isolated air mass activity develops over the ocean at night and inland during the afternoon. The general southeast flow is moist only in the lower levels. Early in the season, the land may cool enough to generate patchy fog and stratus on the coastal plain in the morning.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type B:

(1) Cold Fronts: Downslope conditions make these fronts weak or inactive. A moderate cold front will induce category D middle clouds for at least three hours with intermittent stratocumulus and showers. Post-frontal weather is clear with northwest or northerly winds, if and only if the front does not stall. The Appalachians will retard most fronts of this type for a few hours and may stop others entirely.

(2) Quasi-stationary Fronts: In general, cold fronts settling in from the north slow and stall south of Pope. Ceiling and visibility vary greatly depending on moisture availability and the state of the frontal activity. Fronts with waves or those turning warm may bring category B or even A ceiling and visibility. Precipitation varies from widespread drizzle to heavy rain and thundershowers along the front. Category D middle clouds occur along and north of the front. In general, category B stratus lies along quasi-stationary fronts but may be A in drizzle. Visibility is also dependent on the precipitation type and intensity. It is a good rule to use equivalent ceiling/visibility categories along such a front.

(3) Type B Gulf waves: These tend to move zonally through the Gulf and only produce some middle clouds this far north. The cloud will be heavier if the low explodes over the Gulf Stream northeast of the Florida Coast.

b. Type B_1: These systems develop in the Gulf of Mexico and move slowly northeastward through Georgia combining with a developing wave off Hatteras (hence the name). These well-developed systems are known as "northeasters". The typical warm front progression of clouds occurs with high middle clouds and cirrus lowering to near the ground with the low. In general, expect category D as the low leaves the Gulf, category C to B as the low moves through Georgia and category B to A as the low passes through or along the Carolinas. Skies do not clear up right away as the low passes. The Appalachians hold in backwash category B stratus

in for up to 12 hours. Winds will back to the northwest gusting over 25 knots. For visibility, follow the cloud categories once less than C. Precipitation is usually moderate and steady.

(1) Cold fronts: A very strong polar outbreak follows this system bringing some of the coldest weather of the season. A secondary cold front is likely. A short period of C or D category cumulus will accompany it. Do not be in too much of a hurry to clear the clouds out unless the low is moving up the coast rapidly.

c. Type B_2: These lows move into the Southeast from the Texas Panhandle. Their trajectory is zonal so the actual low center may pass south of Pope but might be north of Myrtle Beach or Shaw. Treat the cold front like a Type B system. If the low center is south of the station, consider taking the ceiling down at least to category C in 6-12 hours of light but steady precipitation. Some thunderstorms are also possible.

d. Type C: The main polar front normally lies well north of the area. Ridging is strong over the Southeast, and temperatures may be well above normal. Haze is possible as the air becomes quite stagnant. The regime lasts for days or weeks. If the flow turns to the water, stratus may develop under an inversion especially for a few hours around sunrise and rising to cumulus in the afternoon.

e. Type E: The Texas Low is of primary interest to this area. The primary development is in the Texas Gulf, and it moves up the west side of the Appalachians. The warm front will develop in the Southeast and move northeastward. It tends to overrun the plain between the Appalachians and the Atlantic Coast because of the mountains themselves, so that a surface analysis shows the warm front as being retarded in Georgia while being much further north of the west side of the Appalachians. A "finger high" will usually be evident on the Plain. Also, a secondary wave may later develop off of Washington, D.C. and further complicate the picture. Usually, the secondary will not develop, however, until the warm front is through North Carolina. Treat like the Type B_1 weather and be very hesitant to move the warm front north more than 10 knots in spite of the explosive movement that takes place on the west side of the Appalachians! In comparison to the Type B_1 situation, the warm front conditions will last twice as long.

SUMMER

a. Type B: Late spring to mid-summer air mass regime, controlled by the position of the Bermuda High. Subsidence tends to suppress air-mass activity. Some cumulus with isolated thundershowers occur in the afternoon. Afternoon

winds are southerly and under 20 knots. If the Bermuda Ridge moves north as is its habit normally in late summer, southeasterly flow prevails. Late morning cumulus ceilings are possible with somewhat more thunderstorm coverage. The upslope wind is apparent, and stratus may form in the early morning.

b. Type E: The Bermuda High is pushed east in this synoptic pattern. Active cold fronts reach the area and trigger thunderstorms. Active fronts generally do not wave but sluggish ones tend to. If the wind becomes northeasterly, it might be a good idea to consider some category B or C stratus and precipitation.

5. SEASONAL FORECAST RULES:

a. In fall and winter, weak easterly flow under a low inversion produces category D haze and smoke at sunrise.

b. Spring through fall: Local moisture sources cause brief sunrise radiation fog if skies are clear and winds calm or very light easterly. Westerly winds do not permit radiation fog to form. Temperatures should fall 15 degrees overnight with temperatures and dew points above 70 and 60 degrees respectively.

c. Advected stratus and fog from the east and northeast can be interpolated from upstream stations. The onset and ending of these conditions follows ILM by one to two hours.

d. Type E: (November through March). When the center of a Gulf Low or Texas Low reaches a point on a line from 34N 88W to 28N 89W, ceilings will have lowered to well below 10,000 feet (5,000 to 7,000). By the time the center reaches a point on a line from 36N 85W to 29N 86W, rain will start at Pope, and ceilings will rapidly reduce to well below 3,000 feet (1,500 to 2,000).

SEYMOUR-JOHNSON AFB (GSB) FORECAST GUIDE

1. UNITS SUPPORTED: 4th TFW (TAC), 68th Bomb Wg (SAC), 8th TDCS (TAC), Det 7, 2nd ADG. Additional amendment criteria are 500 feet, 1 mile, and ½ mile.

2. PHYSICAL DESCRIPTION AND LOCATION: Seymour-Johnson Air Force Base is located in east central North Carolina just south of Goldsboro. The base lies 150 miles due west of Cape Hatteras and is 75 miles northwest of the closest portion of the Atlantic Ocean. The local area is partly cultivated with scattered small towns and areas of woods and swamps. The Appalachians lie 200 miles west and northwest. The terrain slowly slopes down towards the base from those directions. Local land is low and rolling. Field elevation is 109 feet, and the runway orientation is 08-26.

3. PECULIAR FORECAST PROBLEMS:

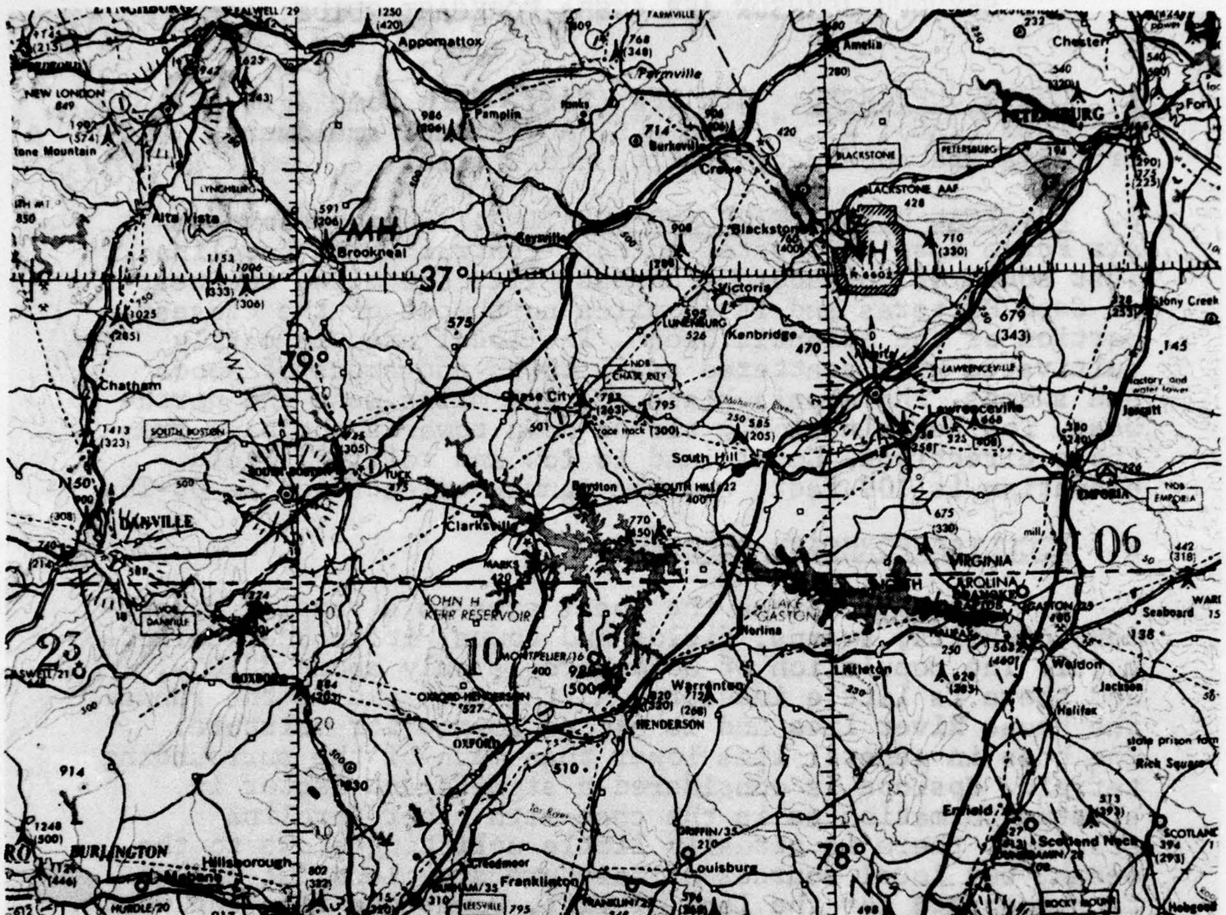
a. Terrain: Since the local area is a complex assortment of hills, swamps, fields and towns, it is best called rural. The population of Goldsboro is only about 30,000, and there is little industry. At the west end of the runway, the Neuse River lies and is a good source for moisture. The base in general lies lower than much of the surrounding terrain. Upslope is considered a significant factor in stratus formation as is the case with other Carolina stations. There is actually little uplifting close to the ocean, but local sources of moisture are plentiful enough to compensate for the lack of lift. Downslope from the west and northwest is significant, for the land begins to rise a few miles west of the base. Pollution sources locally are negligible. Reduced visibility occurs only under periods of stagnation.

b. Transient Controls: See Pope Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Pope Forecast Guide. Note also the following:

a. Type B_1: With the Hatteras Low, backwash stratus ceilings will occur a few hours longer than at POB. Position of low must be half way to Cape Cod before clearing occurs.

5. SEASONAL FORECAST RULES: None.



Appomattox
Amelia
Chester
Farmville
Pamplin
NEW LONDON
Stone Mountain
Burkeville
Crewe
PETERSBURG
BLACKSTONE
LYNCHBURG
Alta Vista
Brookneal
Blackstone
37°
Victoria
Lunenburg
Kenbridge
79°
Chatham
Chase City
Lawrenceville
SOUTH BOSTON
South Hill
DANVILLE
Clarksville
06
VIRGINIA
NORTH CAROLINA
JOHN H KERR RESERVOIR
LAKE GASTON
Norlina
Seaboard
23
10
Warrenton
Littleton
Weldon
Jackson
HENDERSON
OXFORD
Halifax
Rich Square
BURLINGTON
Hillsborough
Creedmoor
Franklinton
Louisburg
78°
Enfield
Scotland Neck
ROCKY MOUNT
Spring Hope
DURHAM
CHAPEL HILL
RALEIGH
Zebulon
WILSON
Pittsboro
Apex
Clayton
Kenly
Farmville
15
SANFORD
79°
Lillington
Smithfield
GOLDSBORO
07
SEYMOUR JOHNSON
KINSTON
PINEHURST-SOUTHERN PINES
POPE
FAYETTEVILLE
Mount Olive
Warsaw

SHAW AFB (SSC) FORECAST GUIDE

1. UNITS SUPPORTED: 363rd TRW (F-4, O-2), 507th TAIRCG (OV-10, O-2, CH-3), 1402 MAS (T-39). Additional amendment criteria of 1500 feet for F-4 training.

2. PHYSICAL DESCRIPTION AND LOCATION: Shaw Air Force Base is located in east central South Carolina 30 miles east of Columbia. The northeast-southwest Atlantic coastline is as close as 100 miles to the southeast, and the Appalachians are as close as 100 miles to the northwest. The base lies on the Atlantic coastal plain with low hills and some swampland. There is only a slight rise in the land from the ocean. The rise increases more rapidly west of Shaw to the Appalachians. Field elevation is 241 feet or slightly higher than the surrounding area. Dual runways are oriented 04-22.

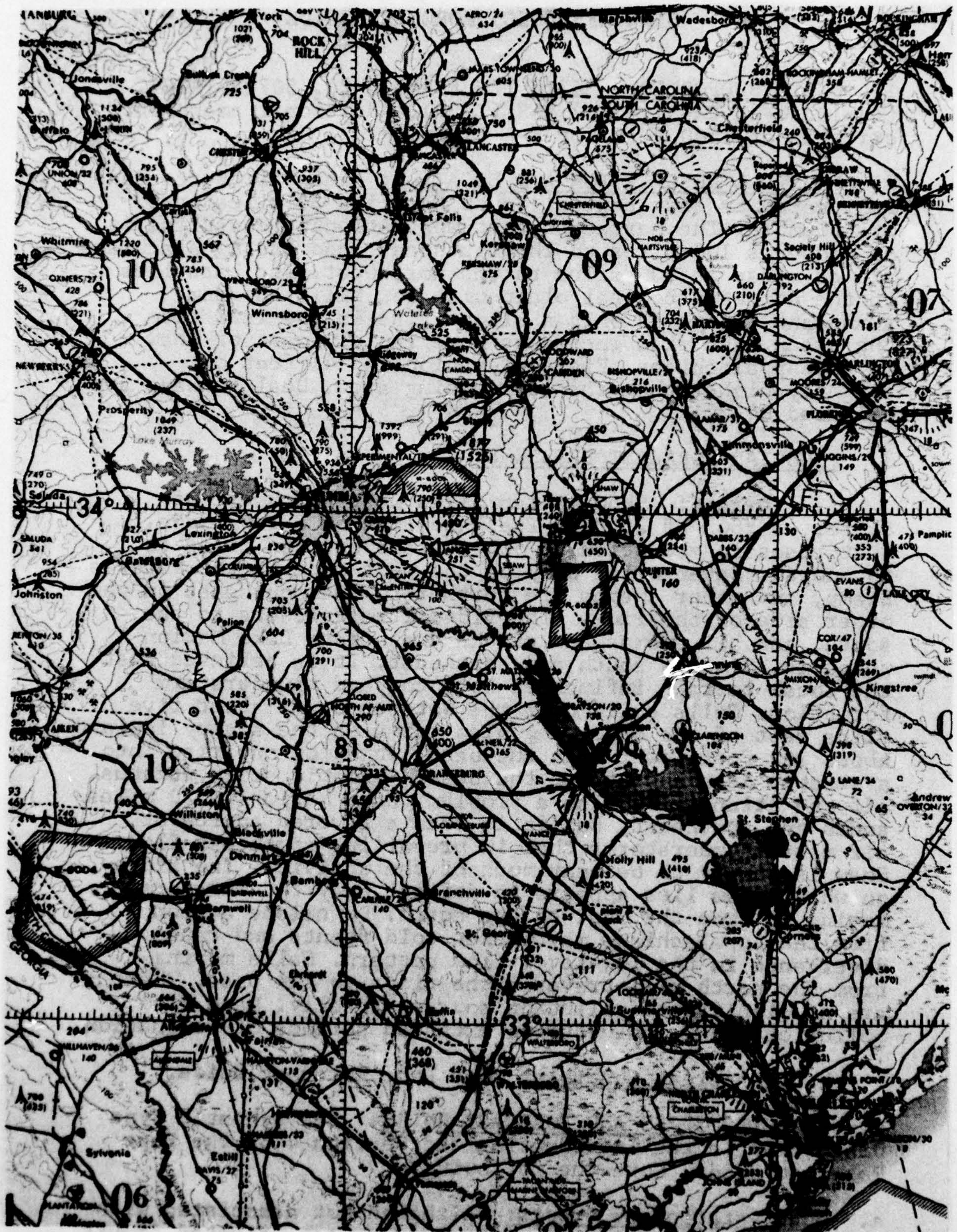
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Shaw is ten miles west-northwest of Sumter, a town of 25,000. The base lies on a low ridge that rises in elevation to 500 feet beyond ten miles to the north. Seven miles away on the west side is the Wateree Swamp, and other swamps lie further to the southeast on the other side of the ridge. The ridge itself lowers to the south, and all swamps and creeks drain into Lake Marion which is 20 miles south and southeast. It is believed that the local terrain influences both fog and thunderstorm formation. Cells build over the Wateree Swamp about five miles west of the base. Fog also forms in the swampy lowland about 100 feet lower than the base. This fog may rise into a stratus deck and affect the base. Synoptic scale stratus off the Atlantic is also a problem. Lake Marion is 20 miles south and southeast, but it is such a favored source of air mass thunderstorms that in prevailing southeast flow, Shaw is likely to be near much of the activity. The ridge on which Shaw lies appears to deflect away thunderstorms moving in from the west to the north. Downslope action from the Appalachians may weaken cold fronts and cause divergence in the low-level flow pattern. Cells moving from the north will traverse the ridge to the base. There are no significant pollution sources locally. Haze from pollution occurs only during extended periods of stagnation.

b. Transient Controls: See Pope Forecast Guide.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Pope Forecast Guide. Note the following:

a. Quasi-stationary fronts: Although not associated with any specific synoptic type, these east-west oriented fronts



York
ROCK HILL
Wadesboro
NORTH CAROLINA
SOUTH CAROLINA
Chesterfield
Jonesville
Buffalo
LANCASTER
Great Falls
Society Hill
Whitmire
Winnsboro
Wateree Lake
CAMDEN
Bishopville
DARLINGTON
NEWBERRY
Prosperity
Lake Murray
FLORENCE
Timmonsville
Saluda
Lexington
Batesburg
Johnston
SUMTER
Lake City
Pamplico
Kingstree
St. Matthews
CLARENDON
AIKEN
ORANGEBURG
Williston
St. Stephen
Denmark
Bamberg
Barnwell
Holly Hill
Branchville
St. George
Ehrhardt
Allendale
Fairfax
Sylvania
Estill
10
09
07
34°
33°
81°
06

slowly settle into the Carolinas with reduced ceilings and visibility on the north side. Up to 4 or 5 "backdoor" fronts can be expected between November and April associated with strong expanding polar highs located over eastern Canada or New England. Typical clouds include category D stratocumulus and middle clouds with category B stratus closer to the front. Visibility is greatly reduced by fog and precipitation with category B conditions prevailing near the frontal area. Any precipitation should be light and intermittent mainly rain and drizzle. Convective activity may occur late in the winter season.

5. SEASONAL FORECAST RULES:

a. The strongest surface winds at Shaw in the winter are southwest or west.

b. Fog formation is frequent in local swamps, and it may be advected on to the base in light southeast or southwest winds.

c. The cold frontal clearing line may be extrapolated from the northwest to Shaw. Clearing occurs 4-6 hours after the windshift.

d. After frontal passage, given a post-frontal wind from the northwest and ceilings below 3,000 feet, clearing may be expected from 4-6 hours after the wind shift. This will be due to adiabatic compression of air from the mountains. The clearing line will be observed at AVL and GSP, and it will then progress rapidly southeastward. (September through May).

e. Given a cold frontal passage during the forecast period, expect little weather (no precipitation) to be associated if there is no moisture at the 700 mb level or above. In most cases, stratocumulus cloud ceilings will stop at the mountains. (15 September through 15 May).

f. Prolonged northeasterly flow over the Atlantic for a period of 12-18 hours, produced by a high pressure system over Pennslyvania, will tend to develop stratus. The stratus will usually form rapidly down the path of the low level trajectory. Westerly component winds should be occurring at least as low as 6,000 feet MSL.

MYRTLE BEACH AFB (MYR) FORECAST GUIDE

1. <u>UNITS SUPPORTED</u>: 354th TFW (A-7). Additional amendment criteria are 500 feet and/or 1 mile.

2. <u>PHYSICAL DESCRIPTION AND LOCATION</u>: Myrtle Beach Air Force Base is located on the northeast coast of South Carolina one-half mile inland from the Atlantic Ocean. The local area is densely populated to the east along the ocean with swamps immediately inland. Field elevation is 35 feet, and the runway is oriented 17-35.

3. <u>PECULIAR FORECAST PROBLEMS</u>:

a. <u>Terrain</u>: The base is on such low terrain that heavy rains from coastal storms may cause local flooding. The local swamps allow fog to affect the base in winter if there is a weak northwesterly flow (drainage). Like many coastal stations where the prevailing summer flow is onshore, late night offshore thunderstorms occasionally may drift onshore at sunrise and generate showers. Air mass thunderstorms in the afternoon tend to develop inland and move away. Pollution is primarily associated with stagnation in the summer normally category D during the night and morning hours. Infrequently, smoke from a paper mill 20 miles southwest will contribute to winter category D visibility at sunrise.

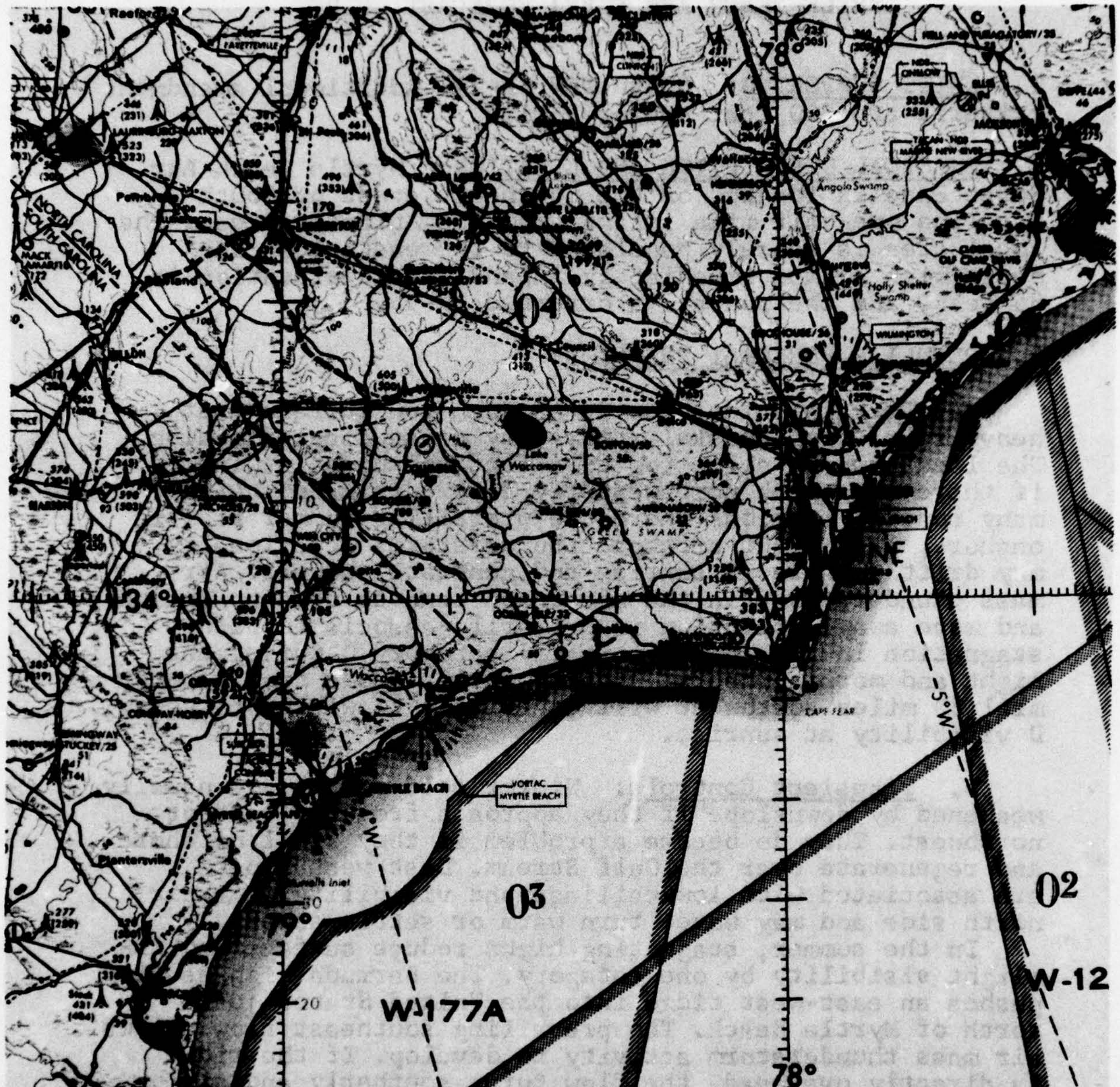
b. <u>Transient Controls</u>: Winter cold fronts are usually weakened by downslope if they approach from the west or northwest. They do become a problem if they stall offshore and regenerate over the Gulf Stream. East-west fronts are associated with low ceilings and visibility on their north side and may wave, turn warm or settle south.

In the summer, stagnating highs reduce surface and in-flight visibility by one category. The Bermuda High usually pushes an east-west ridge into the United States just north of Myrtle Beach. The prevailing southeast flow allows air mass thunderstorm activity to develop. If the ridge is directly overhead, the flow turns southerly and air mass activity is dampened somewhat by subsidence. Tropical cyclones infrequently affect Myrtle Beach. Only Atlantic Ocean hurricanes hit the base full force, as Gulf systems are greatly weakened

4. <u>SYNOPTIC TYPES AND FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction and Section 4 of the Pope Forecast Guide.

5. <u>SEASONAL FORECAST RULES</u>:

a. The sea breeze occurs whenever winds are under 15 knots and the air temperature is significantly above the water temperature, excluding only the winter season. Wind directions are southeast through south-southwest.



4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Tops Forecast Guide.

5. SEASONAL FORECAST RULES:

a. The sea breeze occurs when winds are ... and the air temperature is ... above the water temperature, occurring only the summer season. Wind directions are northeast through south-southwest.

b. Sea fog occurs in winter when dewpoints are at least five degrees above the sea temperature. Winds should be roughly southeasterly and the $T\text{-}T_d$ no more than 3 degrees. Conditions include category B stratus and A category fog. Winds aloft should also be southeast.

c. Sea breeze: Expect the sea breeze to set up when the ambient air temperature rises one degree above ocean water temperature for each knot of prevailing wind. (EX: Water temp = 60°F, wind 270/08, sea breeze sets up at 68°F). Each degree of ambient air temperature in excess of that needed to initiate the sea breeze will cause a gain of one knot in sea breeze strength (usually 15 knots or less). The direction of the sea breeze will be established between 150-200 degrees. For the hour in which the sea breeze is established, the winds will be quite variable. If prevailing winds are 15 knots or greater from other than 150-200 degrees, the sea breeze will not occur.

d. Drainage winds: During early morning (00-07L), a land breeze may form. Conditions needed are no gradient and an air temperature less than the sea water temperature. This flow will be from 300-020 degrees at 1-5 knots.

e. Temperatures: When the sea breeze is 150-180 degrees, the temperature will drop to 2-4 degrees above water temperature and remain there. With sea breeze between 180-200, temperature will be 4-8 degrees above water temperature.

f. Conditions that will bring in sea fog are dewpoint exceeding the sea temperature by 5 degrees or more and a sustained $T\text{-}T_d$ of 3 degrees or less plus favorable wind direction. Forecast W5X¼ mile if the above occurs and wind direction is 150-180 degrees; with wind from 090-150, forecast WX¼3; but forecast a slow change to these conditions. With the wind 180-220 degrees, forecast 300-500 scattered with 300-500 overcast at the south end of the runway only.

g. Gulf wave warm front: Forecast a middle cloud ceiling when the front is progged to reach Jacksonville, Florida. Look for precipitation to begin 6-8 hours after a solid middle cloud ceiling is observed.

h. Air mass thundershowers/ rainshowers: With upper flow (surface-15,000) from 090-110 degrees, forecast no thunderstorms over MYR during day and evening, but instead forecast rainshowers vicinity during the early morning (04-09). These will form over the water and dissipate as they come ashore causing 1-2 hours of stratus ceilings.

i. A strong sea breeze (greater than 10 kts) will tend to keep low ceilings and heavy precipitation away from the field. If the sea breeze is unaffected by a CB in the area, forecast middle ceilings and light rainshowers.

FORT STEWART - WRIGHT AAF (LHW) FORECAST GUIDE

1. UNITS SUPPORTED: 1st Brigade, 24th Infantry Division (U-21, UH-1). 300 feet and/or 3/4ths mile are GCA minimums.

2. PHYSICAL DESCRIPTION AND LOCATION: Wright Army Air Field is located in extreme eastern Georgia near the Atlantic Ocean and South Carolina Border. The closest the Atlantic Ocean comes is 30 miles east-southeast. The small town of Hinesville is just southwest of the base and Savannah, with nearly 125,000 people, is 30 miles northeast. The terrain is flat and swampy with some pine forest. Field elevation is 46 feet, and the primary instrument runways are 05-23 with alternates 14-32. The detachment also supports Evans Army Heliport which is six miles to the northeast.

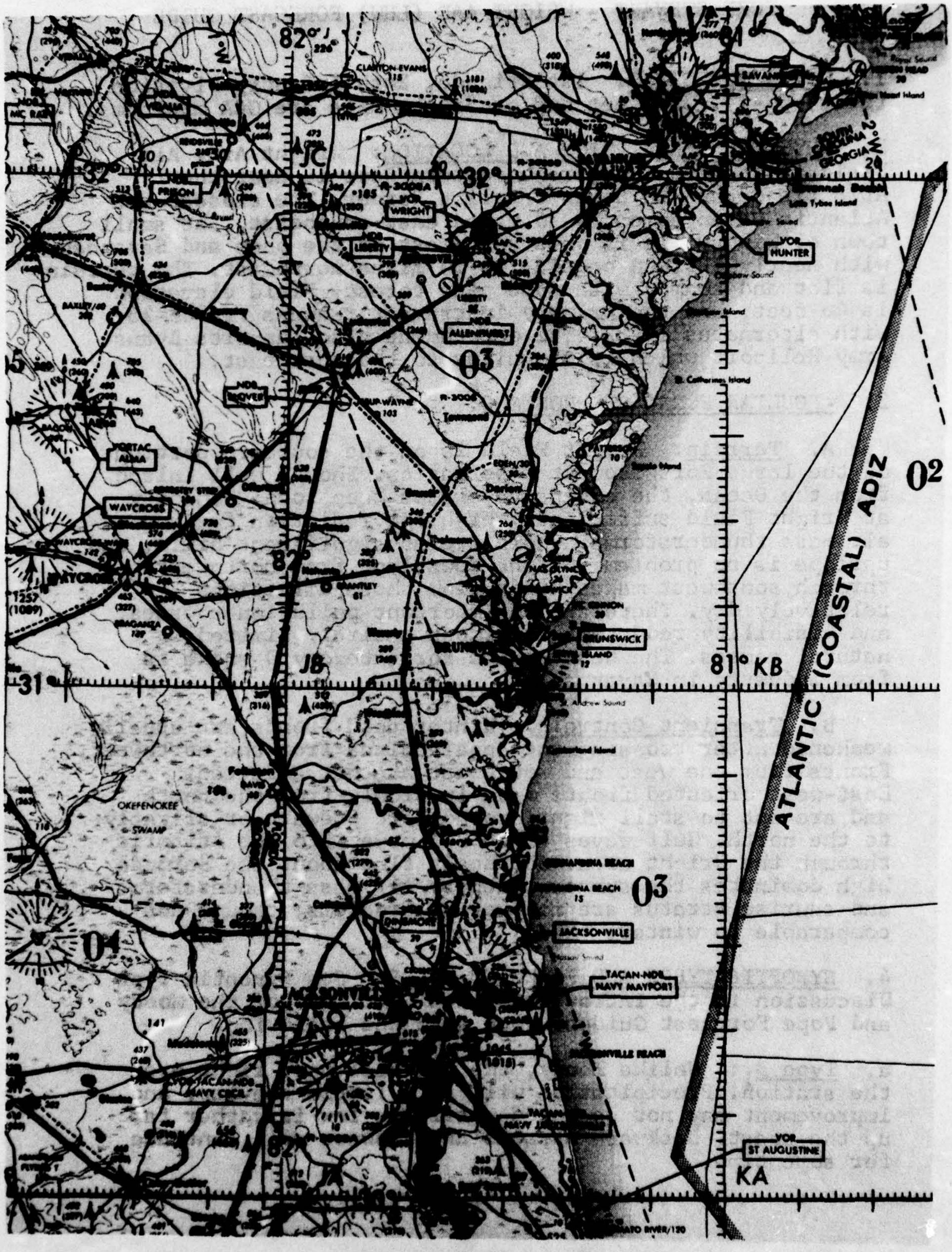
3. PECULIAR FORECAST PROBLEMS:

A. Terrain: Wright Field is on the southern portion of the large Fort Stewart Reservation. Though well inland from the Ocean, the extensive swamps keep local humidity at Wright Field sufficiently high for radiation fog and air mass thunderstorms. There are no significant hills, and upslope is no problem. Slight downslope from northwest through southwest makes winds from those directions relatively dry. There are no important pollution sources, and visibility reduction is almost entirely limited to natural causes. The best chance for category D smoke is from industry in Savannah.

B. Transient Controls: Winter cold fronts are usually weakened after crossing the Appalachians from the northwest. Fronts from the west and southwest are not affected. East-west oriented fronts move in slowly from the north and are apt to stall right around Fort Stewart or slightly to the north. Gulf waves (Type B_1) move into the Atlantic through the Wright area. Southeast flow about the Bermuda High dominates the summer weather. Air mass thunderstorms and sunrise stratus are noteworthy problems, though not comparable to winter.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Moody and Pope Forecast Guides. Note also the following.

a. Type B_1: Unlike Moody, the low will move right over the station. Precipitation will be a little heavier, and improvement may not be noted until the low is rather far up the coast. Backwash stratus and showers will continue for some time.


ATLANTIC (COASTAL) ADIZ
0²
0³
0³
0⁴
82°
82°
32°
31°
81° KB
JC
JB
KA
VOR HUNTER
VOR ST AUGUSTINE
TACAN-NDB NAVY MAYPORT
VORTAC ALMA
WAYCROSS
BRUNSWICK
JACKSONVILLE
OKEFENOKEE
SWAMP
SOUTH CAROLINA
GEORGIA
NDB ALLENHURST
VOR WRIGHT
VOR LIBERTY
PRISON

b. Type C: With Wright being considerably closer to the water, stratus is much more likely with northeast through southeast low level flow.

c. Type B, Summer: Late night thundershowers develop in the Atlantic offshore and move in as showers near sunrise. Yet Wright is far enough inland to get thunderstorms that develop during the day and dissipate in the evening. Wright has more days of thunderstorms than most reporting stations in the area.

5. SEASONAL FORECAST RULES:

a. Radiation fog in southeast flow may rise to category B stratus in winter (C at other times of the year). Normally, it will break by noon.

b. Thunderstorm bases are typically category C in the winter and D in less intense summer activity.

c. Post-frontal winds after moderate cold front passage may be 20 knots for up to 36 hours.

d. In the summer, if thunderstorms occur on one day, they are very likely to occur on the next day also (May-Oct).

e. If the 06L visibility is 6 miles due to fog, more than likely the visibility will decrease to 3 miles before 1000L. (September-December).

f. If a front passes LHW and becomes stationary a short distance to the south, LHW will experience low ceilings and visibility (especially during late summer through winter).

g. A front that passes LHW from the northeast during the summer will usually become stationary before passing through Georgia (May-September).

h. A strong high pressure cell in or just north of the Gulf of Mexico will give LHW extremes of temperature. (May through April).

i. If precipitation occurs during the day or especially during the early evening, fog is likely to be heavy the next morning (May through April).

j. If a squall-line develops ahead of a cold front, there will be little weather with the front as it passes LHW (February through May).

MOODY AFB (VAD) FORECAST GUIDE

1. **UNITS SUPPORTED**: 38th TFW (F-4).

2. **PHYSICAL DESCRIPTION AND LOCATION**: Moody Air Force Base is located in extreme southern Georgia eleven miles northeast of Valdosta. Though well inland, swamps lie throughout the local area in all directions from northeast through south to southwest. The land to the northwest is low and rolling, and the Appalachian foothills rise 150 miles in that direction. The Atlantic Ocean is 100 miles east and the Gulf of Mexico 75 miles southwest. Field elevation is 233 feet, and the runways are oriented 18-36.

3. **PECULIAR FORECAST PROBLEMS**:

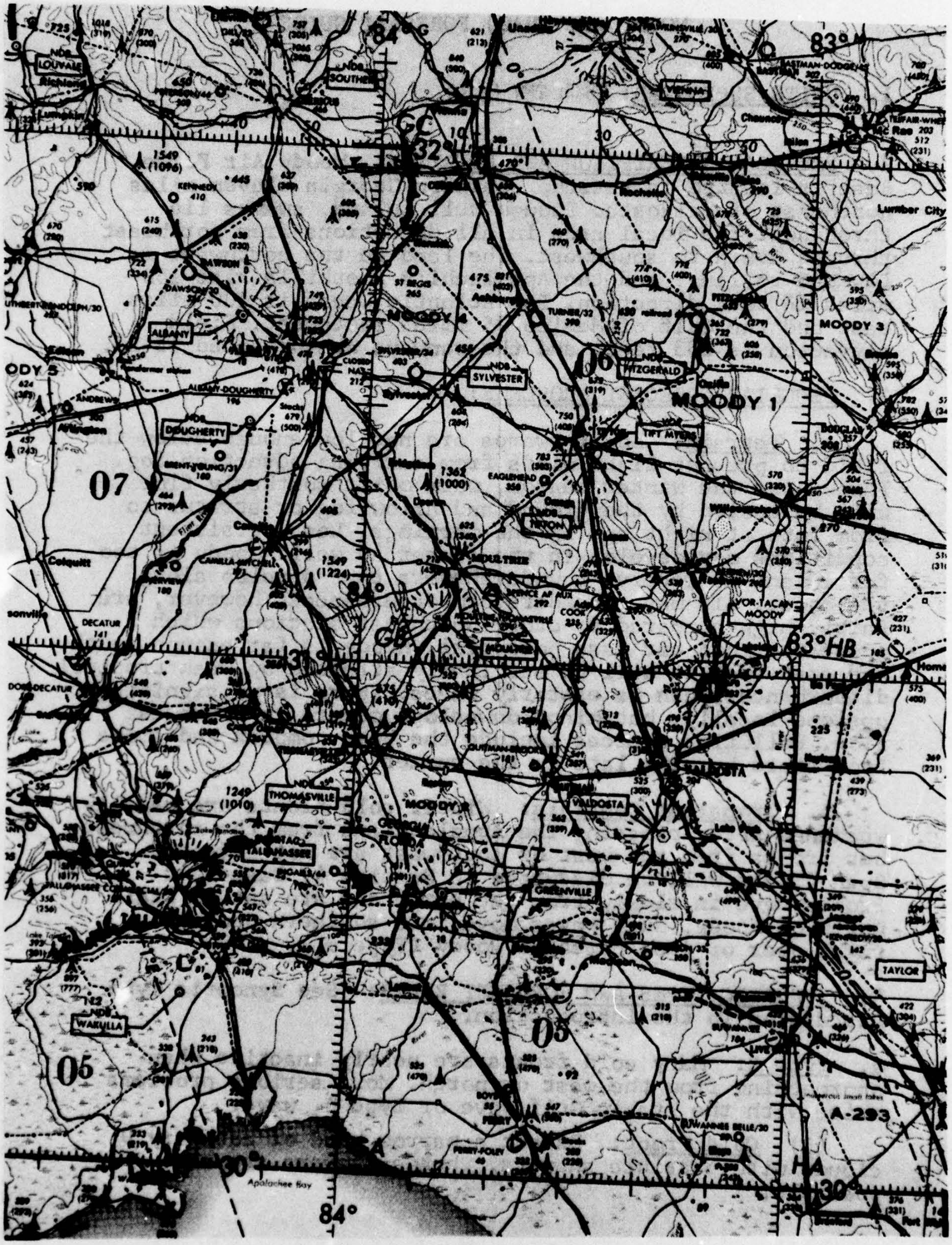
a. Terrain: Local swamps are not low enough below the field to prevent light winds from carrying advection fog. Throughout the winter season, warm moist southerly flow will be cooled by the ground and allow fog or stratus to from late at night and in the mornings. Less persistent conditions may develop in the summer as well. Moody is too far inland to receive thundershowers that develop along the coast. Air mass thunderstorm occurrences, however, are fairly high compared to other Southeast stations which indicates good air mass potential. Moody is far enough south and east that it will be marginally affected by weak tropical disturbances auch as easterly waves. There is no significant upslope locally, but minor downslope occurs in northwest flow. Pollution sources include the base complex and smoke from field burning late in the summer.

b. Transient Controls: Winter cold fronts are usually weakened after crossing the Appalachians from the northwest, but fronts from the west or southwest are not affected. Such fronts will be discussed in Section 4. East-west fronts move in slowly from the north and are apt to stall north of Moody. Gulf waves move into southern Georgia right over or just north of Moody (Type B_1).

4. **SYNOPTIC TYPES AND FORECAST RULES**: See Synoptic Type Discussion in the Introduction.

a. Type B: Many cold fronts are nearly inactive when approaching from the west or north. More serious problems arise with the stable Gulf wave or Type B_1 wave.

(1) Cold Front: Expect a narrow band of category D clouds with possible showers. Thundershowers are also possible.



LOUVALE
SOUTHERN
VIENNA
84°
83°
32°
Lumber City
DAWSON
ALBANY
MOODY 3
MOODY 1
FITZGERALD
SYLVESTER
TIFT MYERS
DOUGHERTY
07
06
05
Colquitt
DECATUR
VOR-TACAN MOODY
83° HB
31°
THOMASVILLE
VALDOSTA
TALLAHASSEE
GREENVILLE
TAYLOR
WAKULLA
A-293
30°
Apalachee Bay

(2) Stable Gulf wave: Progression of wave is into Florida. Middle clouds increase and give way to C category ceilings and light intermittent precipitation as the low moves into Florida. Slow clearing will follow.

b. Type B_1: Classical Hatteras Low originates in the central Gulf and moves onshore in the Florida Panhandle to southern Georgia and thence up the East Coast. A secondary formation in the Hatteras area is likely, and the storm may get quite intense. Developing middle clouds in the central or western Gulf become obvious from coastal station reports, and the shield may be extrapolated into the Moody area with good results. While the wave is opposite New Orleans, high clouds will begin with precipitation beginning about 4 hours later. As the wave approaches landfall in the Panhandle of Florida, category C stratus moves in with fog and general rain with conditions lowering to B until the wave passes. Post-low weather is category C stratus which will hold on tenaciously until the main low is well up the East Coast. A strong polar outbreak will follow this low and bring some of the coldest weather of the season.

c. Type B_2: This low moves eastward from the Oklahoma Panhandle and moves north of Moody. Expect a period of category C ceilings in light steady precipitation and possible thunderstorms. Although the low moves slowly, clearing behind the system will be abrupt.

d. Type C: High pressure over the Southeast. Unseasonably warm temperatures and some haze due to stagnation occur. Regime may last for weeks. Some category C stratus may spread as far west as Moody but unlikely during periods of prolonged southeast-northeast flow.

e. Type E: The Texas Gulf low moves up the west side of the Appalachians allowing the warm front to approach Moody. Its movement will be slower through southern Georgia than the low would lead one to expect. As a result, do not move the clouds northward too fast. Forecast the same conditions as with B_1. The only difference is that there will be a definite warm front passage with this type. Rapid improvement occurs after the front passes. As the cold front approaches, clouds again form and remain until the front is out over the Atlantic. A squall-line will almost always accompany this front. A moderate polar outbreak occurs behind this system.

f. Type E_s: Treat like stable Type B waves at Moody.

SUMMER

a. Type B: In the spring, the Bermuda High pushes west into Georgia north of the base. Some low level inflow, category D stratocumulus, may occur when waves move through the Midwest, but such activity is usually restricted to the central and western Gulf areas. Air mass thunderstorms develop in the afternoon. There is no preferred location. Brief sunrise radiation fog may occur the morning after a good rain. Easterly waves and weak tropical disturbances affect Moody. Category D ceilings and intermittent precipitation are typical.

b. Type E: Late in the season, fronts approach from the northwest. The Bermuda High is forced eastward. Thunderstorm coverage is greatly enhanced with squall-lines possible. If the high stagnates to the northeast, category D haze may occur.

5. SEASONAL FORECAST RULES:

a. Winter sunrise fog and stratus may occur when $T\text{-}T_d$ is small, and weak winds are northeast through southwest. Usually these conditions are being reported elsewhere.

b. Category C or less fog never occurs with dewpoints below $40^{o}F$.

c. All seasons but more prevalent in fall through early spring: (Stratus and fog). With a small $T\text{-}T_d$ ($2\ ^{o}$) near daybreak, and a gradient wind from northeast clockwise through southwest, watch for low stratus and/or fog to move into the area around 0800L especially if the stations upstream have reported stratus and/or fog.

d. Fog: In all seasons, if the previous day dewpoint is less than $30^{o}F.$, visibility the next morning will be 5 miles or greater.

e. All seasons: Fog; When 0400L dewpoint is less than $40^{o}F$, visibility will be 3 miles or more.

f. Spring through fall: Showers; In the absence of clouds in the morning and no inversion above 10,000 feet with a dewpoint equal to or greater than $0^{o}C$ at 700 mb and a stability index equal to or less than 0, forecast showers. With a dewpoint less than 0^{o}at 700 mb and a stability greater than 0, forecast no showers.

ROBINS AIR FORCE BASE (WRB)

FORECAST GUIDE

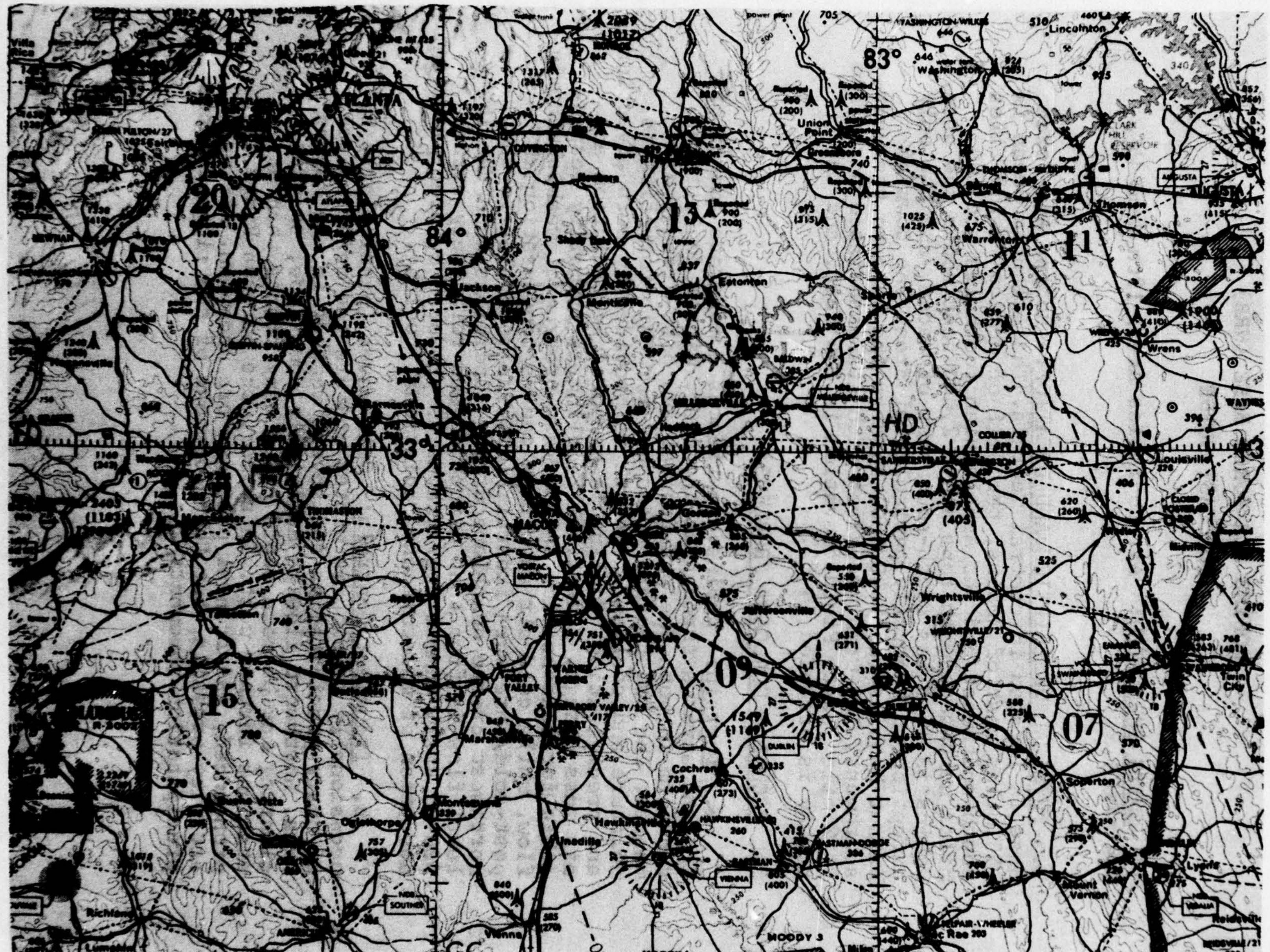
1. UNITS SUPPORTED: Air Logistics Area, 19th Bomb Wg, Hqs AFRES.

2. PHYSICAL DESCRIPTION AND LOCATION: Robins Air Force Base is located in central Georgia. The Atlantic Ocean is 155 miles east of Robins, the Gulf of Mexico is 185 miles south-southwest and the Appalachian foothills are 100 miles northwest with tops above 2,000 feet above the base. Robins is 15 miles south-southeast of Macon, and the only exception to generally agricultural area. The town of Warner Robbins (pop. 40,000) borders the base to the west-southwest. The Ocmulgee River with its associated marshland is 2 miles east. Field elevation is 294 feet, and the runway is oriented 14-32.

3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Robins experiences a moderate amount of fog and stratus throughout the year. Winter fog/stratus can form in both the pre-frontal and post-frontal air masses. The two factors necessary for this formation is moisture and cooling. Moisture is provided by both advection and precipitation. Cooling is produced by radiation and air mass change. Radiational cooling is primarily responsible for condensation in the warm prefrontal weak southerly flow, while cold air advection causes condensation in post-cold/ pre-warm frontal flow. The mountains to the northwest create downslope drying conditions when the low level flow is from that direction and relatively strong (20-25 kts). Summer fog/stratus is produced by precipitation, advection of moisture and radiational cooling.

b. Transient Controls: Gulf waves (particularly B_1) occasionally develop in winter and are the major source of heavy precipitation and severe weather in the Robins area. Northwest flow is definitely downslope, so that clearing may be more rapid after many fronts than at stations further west. In summer, the Bermuda Ridge is pronounced, and frontal passages are uncommon. Air mass activity prevails, but the closeness of the ridge reduces precipitation somewhat.



Lincolnton
Washington
83°
84°
33°
Union Point
Greensboro
Warrenton
Thomson
Augusta
Wrens
Louisville
Eatonton
Jackson
Macon
Wrightsville
Soperton
Cochran
Hawkinsville
Oglethorpe
Vienna
Lyons
Mount Vernon
Atlanta
13
11
HD
09
07
15
20

4. <u>SYNOPTIC TYPES AND FORECAST RULES</u>: See Synoptic Type Discussion in the Introduction.

a. <u>Type A</u>: Low level troughing on the lee side of the Appalachians allows weak cold fronts to trail into the local area. The effects of the continental outbreak that moves through the Ohio Valley are absolutely minimal. Downslope eliminates virtually all of the clouds which normally accompany this front.

b. <u>Type B</u>: Though surface pressures are higher than in the last case, fronts are still more likely to pass through the area. Haze will increase under the influence of a stagnating anticyclone. Gulf waves occasionally develop on the trailing cold front and travel zonally through Florida. (See Types B_1 and B_2 for other possibilities.)

c. <u>Type B_1</u>: This is the classical Hatteras Low. The warm sector of an unstable developing Gulf wave usually originates in southern Georgia or Alabama. This implies that the low center will move eastward right near Robins. Category D altocumulus rapidly lowers to B category nimbo-stratus. Rain and drizzle are widespread and especially heavy near the developing low center. A new low will also develop near Hatteras, and as the lows merge clouds and precipitation hang on tenaciously in Georgia until the main low is well up the coast. A strong polar outbreak will occur behind low.

d. <u>Type B_2</u>: This Panhandle stable wave will normally move north of Robins. Expect a six-hour period of low ceilings with showers. In late Winter, a squall-line is possible. Clearing occurs rapidly behind the system.

e. <u>Type C</u>: General high pressure lies over the Southeast causing stagnation and unseasonably warm temperatures.

f. <u>Type D</u>: Cold fronts from the Colorado Low trail into the Gulf. Their movement is generally sluggish. Continental cold outbreaks are usually weak. A band of weather will accompany the front usually category D stratocumulus which lowers to C with any precipitation. Clearing is apt to be slow as the southern portion of the Appalachians tends to hold the front up. If wave action occurs, treat like a weak Type B_1.

g. <u>Type E</u>: Whether the lows develop in the Panhandle or in the Gulf is unimportant with the track always west of the Appalachians. The warm front is always a problem, and the cold front is also significant as a moderate polar outbreak will occur.

(1) Warm Front: Activity along the front will be spotty at first. Expect category D clouds to lower to C in precipitation (intermittent light rain). The rain will become moderate just before passage. Keep in mind that the front will move more slowly northward east of the Appalachians than on the west. This will probably cause one to break up the clouds too quickly. Clearing occurs in the warm sector.

(2) Cold Front: By the time the low gets up to West Virginia, the cold sector is moving rapidly eastward. A squall-line is a real threat. Some backwash stratocumulus will occur in the cold air but rarely for more than six hours.

h. Type E_s: The basic upper air flow looks like Type B_2 south of 40 degrees north. Migratory upper air troughs from the Southwest U.S. readily generate Gulf waves. An extended period of category C ceilings and steady light precipitation will occur as the low moves into Florida. Proximity of the low to Robins will determine the extent of the weather observed.

SUMMER

a. Type B: During late spring, the Bermuda Ridge builds across the East Coast north of Robbins. This feature dominates the weather in general. Later in the season, increased isolated thunderstorm activity occurs. On mornings following this activity, sunrise category C radiation fog can occur under a clear sky. Occasional weak tropical disturbances which affect the coast also affect Robins. Stagnation may also occur when the Bermuda Ridge overlies Robins and may increase the chance of category C at sunrise.

b. Type E: Unusually deep troughing aloft over the eastern half of the country drives the Bermuda High east and allows cold fronts to move into Georgia. This indicates possible squall-line activity if the front approaches in the afternoon or evening.

5. SEASONAL FORECAST RULES:

a. After extensive thunderstorm activity, sunrise fog and stratus are likely the next day (B clouds and D category visibility). The probability rises if air mass activity has occurred for two or more consecutive days.

DOBBINS AFB (MGE) FORECAST GUIDE

1. UNITS SUPPORTED: 94th TAW (C-7), 116th GANG (F-100), Army Reserve Flight Facility (OV-1), Fulton County (Army Det), SWO (Fort McPherson).

2. PHYSICAL DESCRIPTION AND LOCATION: Dobbins Air Force Base lies on the northwest side of Atlanta, Georgia in the northwest portion of the state. This area is in the southern end of the Appalachians consisting of many hills and small ranges alternating with valleys. Since Atlanta itself is over 1,000 feet above sea level, there are no hills locally over 2,000 feet above Dobbins. However, mountains over 5,000 feet lie only 50-100 miles northeast. At their closest points, the Atlantic Ocean is 250 miles southeast, and the Gulf of Mexico is 300 miles south-southeast. Atlanta has a population of 500,000 alone, so Dobbins is in an urban setting. Marietta, with a population of 30,000, is northwest of the base. Nevertheless, there is some open country northeast which is rather hilly. There are reservoirs in the local area. Field elevation is 1,068 feet, and the runway orientation is 11-29.

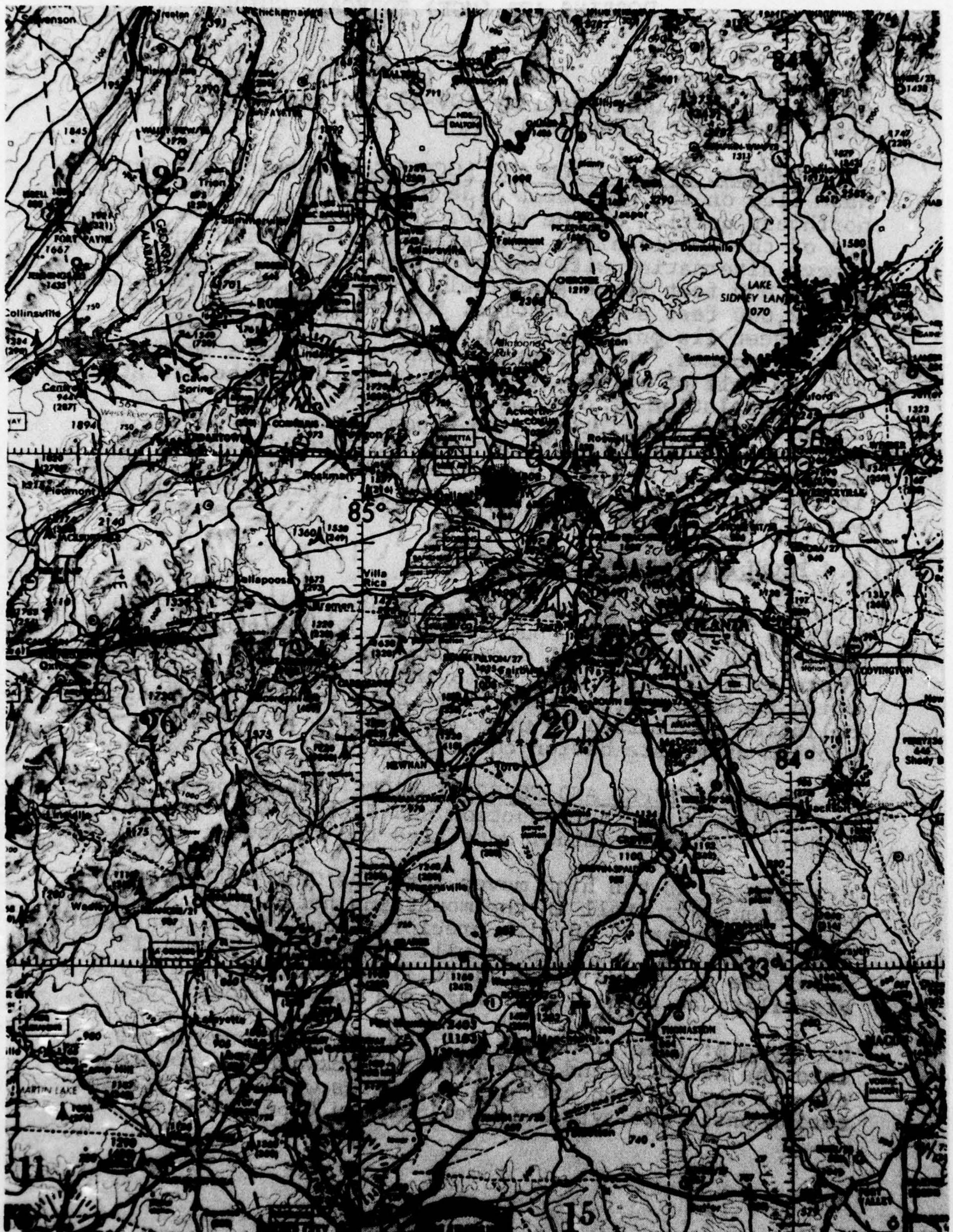
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Dobbins is in a very hilly setting as well as in a heavily populated area. Low mountains extend beyond 100 miles in all directions except the southeast. There is a definite upslope moving northwest towards Dobbins which causes problems when flow is out of the southeast. Pollution is limited to urban causes and is chiefly a problem under stagbation conditions.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the WRB (Robins) Forecast Guide. Note also the following additions.

a. Type A: As the high moves into the Ohio Valley, the weak front may stall in the mountains near Dobbins. Clouds will be category C (B with precipitation) due to the 1,000 foot elevation, and showers will normally be light. If slies are clear and winds light, look out for category D visibility at sunrise with haze and patchy ground fog.

b. Type B: (See also Type B_1). As the Gulf wave moves into the Atlantic and intensifies, backwash and mountain effects may hold in category C stratus with light precipitation until the system is well beyond Cape Hatteras.


Stevenson
Trenton
Chickamauga
Collinsville
Cave Spring
Piedmont
Tallapoosa
Villa Rica
85°
Newnan
LAKE
SIDNEY LANIER
Jasper
84°
COVINGTON
33°
THOMASTON
MARTIN LAKE
15
11
20
26
44

c. Type D: The cold front moves more sloppily through the Dobbins area than other stations in the Southeast. First of all, it slows down. Second, B category ceilings will form with C visibility in precipitation and fog. As the cold air moves in behind the front, stratus will form and persist overnight into the morning hours.

d. Type E: Make the same modification for the cold front as in Type D above.

SUMMER

a. Type B: Air mass thunderstorms are more common in the mountains and form very near the base. Heaviest coverage is to the west and north where most storms drift away from the base in southeasterly flow aloft. Dobbins will have ground fog and haze at sunrise if grounds are wet.

b. Type E: Thunderstorms over the mountains should drift over the base in west or northwest flow aloft.

5. SEASONAL FORECAST RULES: None.

MACDILL AFB (MCF) FORECAST GUIDE

1. UNITS SUPPORTED: 56th TFW (F-4 Training), SAC Det (B-52, KC-135). Additional amendment criteria are 2,500 feet, 1000, 500 feet and/or 1 mile (Training minimums).

2. PHYSICAL DESCRIPTION AND LOCATION: MacDill Air Force Base is located at the south end of the Interbay Peninsula between Tampa and St. Petersburg, Florida. Tampa is just north, while St. Petersburg is ten miles southwest. Both arms of the bay on either side of the base are just over five miles wide with the Gulf of Mexico 20 miles west. The area around the base is moderately urban, and nearly 500,000 people live within 20 miles of the base. Field elevation is 13 feet, and the runway is oriented 04-22.

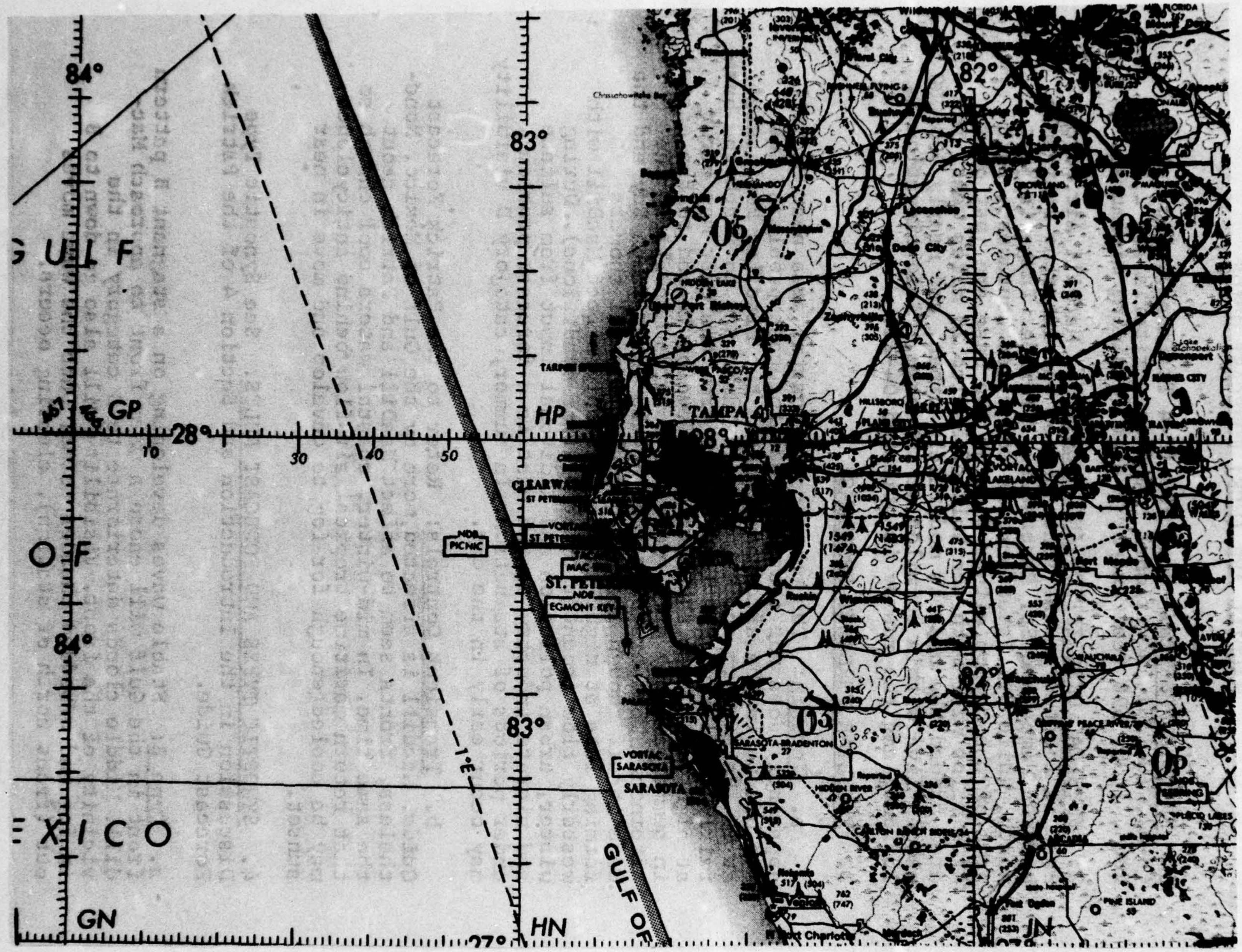
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: The complicated coastal area near MacDill apparently does not cause serious forecast problems. The sea breeze in the afternoon crosses the Pinellas Peninsula at St. Petersburg and the western Tampa Bay to reach the base fairly regularly. The land breeze from the east may occur at night. Air mass thunderstorms develop inland to the east in summer and may drift westward towards MacDill in the afternoon. Thunderstorms also develop over Tampa Bay and the base itself though less frequently. Coastal showers forming late at night in the Gulf only affect MacDill with westerly flow (counter to prevailing conditions). During winter, urban pollution and additonal input from sulfate and nitrate industry to the east is a forecast problem under periods of stagnation. In summer, category D visibility may occur early in the day.

b. Transient Controls: Refer to the Patrick Forecast Guide. Macdill is affected more by the Gulf of Mexico. Nonetheless, fronts seem to affect MacDill and Patrick about the same time. In mid-winter, coastal waters cool enough so that return maritime tropical air flow behind anticyclones may be cooled enough for fog to develop and move in near sunset.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction and Section 4 of the Patrick Forecast Guide.

a. Type B: Stable waves developing on a stagnant B pattern front in the Gulf will cause a warm front to approach Macdill. Middle clouds deteriorate to B category in the vicinity of the front. Visibility will also go down to B in fog and embedded thunderstorms. Once the wave moves out (front north of station), clearing occurs.



GULF OF MEXICO
GULF OF
84°
83°
82°
28°
27°
GP
HP
GN
HN
JN
10
30
40
50
1°E
TAMPA
CLEARWATER
ST. PETERSBURG
SARASOTA
LAKELAND
NDB PICNIC
NDB EGMONT KEY
VORTAC SARASOTA
SARASOTA-BRADENTON
HIDDEN RIVER
Chassahowitzka Bay

b. Type B, Summer: MacDill differs from Patrick in that air mass activity moves toward MCF in the afternoon, and morning coastal showers are unlikely. The annual precipitation of 44 inches, however, is not high despite the rather high frequency of thunderstorms. Thunderstorms are more active at MCF in southwest flow.

5. SEASONAL FORECAST RULES:

a. Frontal passages in winter are forecast from the 850 mb wind field behind the front. Fronts stagnate when winds are west or southwest. Northwest flow should push the front through.

b. Winter advection fog: Fog is held out in the Gulf until evening cooling occurs. Coastal stations are a good indicator of deteriorating conditions (particularly St. Petersburg).

PATRICK AIR FORCE BASE (COF)

FORECAST GUIDE

1. UNITS SUPPORTED: N.A.S.A. (KC-135, C-118), AFETR (OV-10, O-2).

2. PHYSICAL DESCRIPTION AND LOCATION: Patrick Air Force Base is located on the Atlantic Coast of central Florida 150 miles south-southeast of Jacksonville 175 miles north of Miami and 15 miles south of Cape Kennedy. The base lies on a narrow strip of land just off the Florida mainland. The largest local city is Melbourne five miles southwest with a population of over 40,000. Field elevation is 8 feet, and the runway orientation is 03-21.

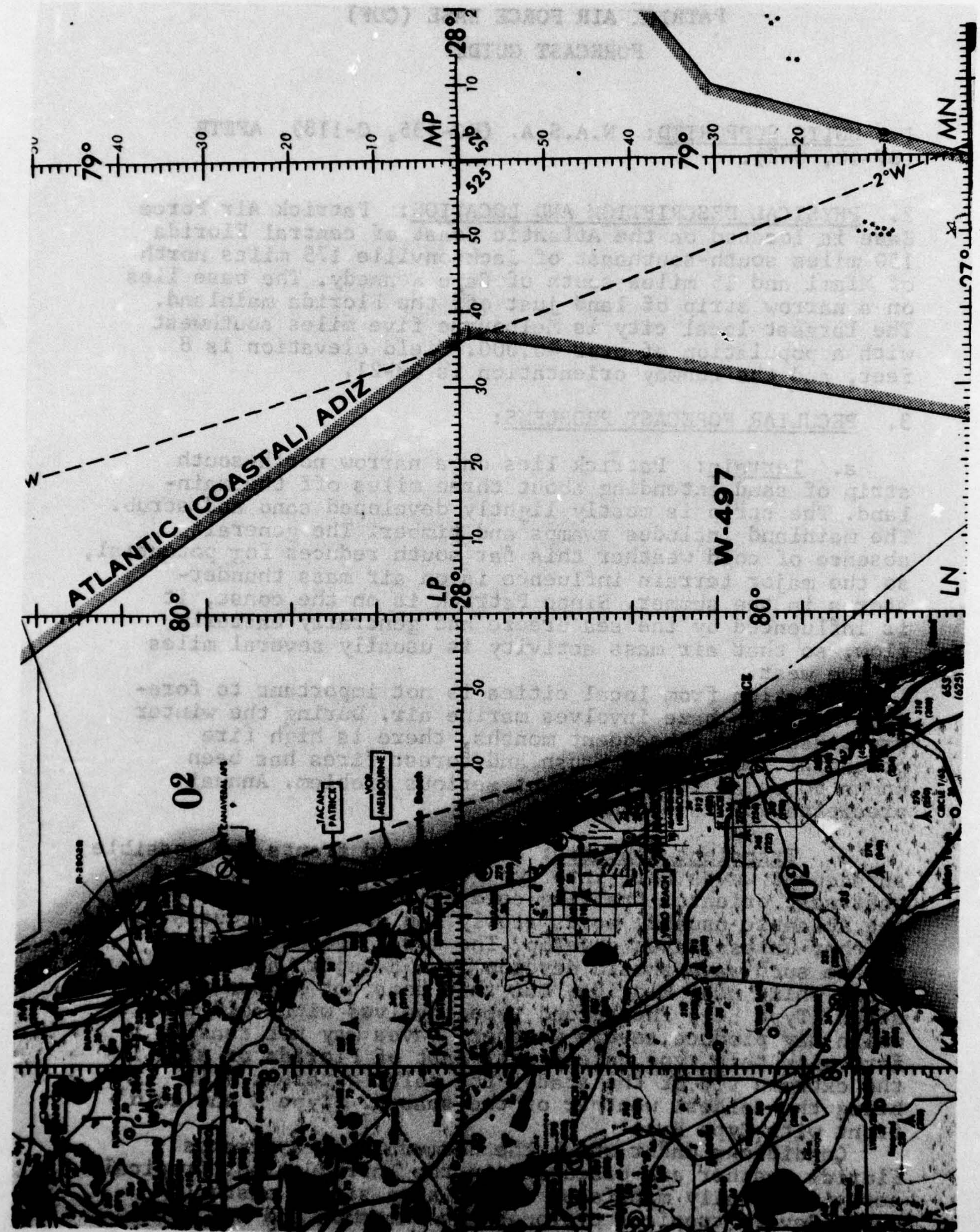
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Patrick lies on a narrow north-south strip of sand extending about three miles off the mainland. The strip is mostly lightly developed sand and scrub. The mainland includes swamps and timber. The general absence of cold weather this far south reduces fog potential, so the major terrain influence is on air mass thunderstorms in the summer. Since Patrick is on the coast, it is influenced by the sea breeze and generally easterly flow, so that air mass activity is usually several miles to the west.

Pollution from local cities is not important to forecasting. Most haze involves marine air. During the winter dry season and subsequent months, there is high fire potential. Smoke from brush and forest fires has been known to be an infrequent but serious problem. Annual precipitation is 46 inches.

b. Transient Controls: Winter cold fronts and possible subsequent waves fall into two general categories. The east-west oriented trailing cold front from systems out in the Atlantic usually moves slowly and usually produces little weather unless waves develop. The worst weather occurs if one such wave should develop into a major East Coast storm while near Florida, but this does not happen very often (Type B_1). The second type involves with cold fronts which may produce severe weather. Waves may not readily form with this type unless well east of Florida or else in the extreme tip of the state. The polar outbreak will bring the coldest weather of the season. (Type E and cold front with Type B_1).

Conditions under which the Bermuda High dominates Florida weather are discussed in the Introduction. Tropical activity usually manifests itself as a single easterly wave. Severe tropical cyclones are uncommon and may not appear at all in some years. Occasional troughing may generate thunderstorms in southwesterly flow (spring).



appear at all in some years. Occasional troughs may
generate thunderstorms in southwesterly flow (spring).

4. **SYNOPTIC TYPES AND FORECAST RULES:** See Synoptic Type Discussion in the Introduction.

a. Type B: Cold fronts trailing through the area. Possible waving in the Gulf. Waves are usually stable. Type B_2 is not discussed separately as the cold front weather is like Type B. The Hatteras Low is Type B_1 discussed below.

(1) Cold Front: Maritime fronts include some middle clouds, stratocumulus and westerly flow. More active cold fronts produce category D ceilings. Some of the fronts do not reach Patrick at all.

(2) Stable Gulf Waves: Front that passes will return as a warm front. Middle and high clouds increase. Expect C (occasional B) category ceilings and visibility on the front in rain, fog and embedded thunderstorms. It will be likely clear or scattered conditions in the warm sector. Return of a cold front will depend on the strength and location of the wave. Obviously if these is a northerly push behind the low, the cold front will pass again. Treat like the original front that passes.

b. Type B_1: The degenrate Type B allows an unstable wave to form which will move into southern Georgia and eventually develop into a major East Coast storm. Again, a warm front will approach Patrick with similar weather as the Type B wave. The cold front will be quite strong and bring some of the coldest weather of the season.

c. Type E: The Texas Gulf low is well to the northwest of the station but pushes a rather strong cold front through the area and may be intense by Florida standards. If a squall-line accompanies the front, severe weather is a definite possibility especially in the spring. Ceilings will be generally C in thunderstorms. In the absence of a squall-line, category D middle clouds and stratocumulus occurs near the front and for a few hours thereafter. Pre-frontal winds are southwesterly shifting to northwesterly.

SUMMER

a. Type B: Fair weather regime includes continual easterly flow, strongest in the afternoon with gusts to 15 knots. Inland air mass thunderstorms remain to the west. Sunrise showers may move in from the east on occasion (off the ocean). Brief late morning cumulus ceilings occur. Easterly waves and depressions bring category D and C ceilings with steady rain and embedded thunderstorms.

5. **SEASONAL FORECAST RULES:**

WINTER

a. If a low develops in the Gulf of Mexico, the associated cold front will pass Patrick.

b. If a cold front is preceded by an active squall-line, very little cloudiness or weather will be associated with the frontal passage.

c. Weather will clear slowly after cold front passage if a distinct trough at 700 mb is found at this latitude west of Patrick. Conversely, rapid clearing may be anticipated following a cold front if the winds at 700 mb and higher veer to the northwest.

d. If the winds from the surface to 3,000 feet remain northerly after a cold front passes, and winds from 3,000 to 15,000 feet start backing to southerly or southwesterly, rapid deterioration of local weather may be expected as the front moves backward to the north as a warm front.

e. Strongest winds are associated with squall-lines that move in from the northwest with a northeast-southwest orientation.

f. Radiation fog forming over the mainland in early morning hours with a light southwesterly flow will be advected over the station at daybreak as low stratus (300 to 600 feet). This stratus will dissipate rapidly by 0930L.

g. Fog/stratus may persist for 24 or more hours in succession when a slow-moving cold front stalls between Vero and Patrick.

h. Ground fog which occurs at the south end of Patrick will not lower runway visibility.

i. Low level flow from 010° and a long over water fetch (Brunswick, Ga. to Cape Hatteras) with wind speed 10-20 knots will produce stratocumulus over Patrick; strong northeast flow (20-25 knots) will produce numerous rainshowers; and clearing will occur almost simultaneously with any wind shift past 080 degress due to the warming effect of the Gulf Stream.

j. Southwest flow at or above 8,000 feet will give broken to overcast clouds at or near that level from 10 to 14 hours after flow is established.

k. Air mass thunderstorms never occur over Patrick during the coldest months (November through February).

l. During the period November through April, northeast winds never produce thunderstorms.

SUMMER: Air Mass Regime (June - September)

a. Fronts seldom affect this region during this period.

b. Never forecast fog or low stratus.

c. May-July: If there is a thunderstorm today, there is a 90% probability of a thunderstorm tomorrow. August through October - this probability decreases to 51%.

d. July - mid-August: West or southwest winds precede thunderstorms over 75% of the time.

e. Mean duration of thunderstorms is 1½ hours for all periods.

f. If the mean or climb wind from the surface to 20,000 feet is between 230-270° and between 30-55 knots, there is an 80% probability of thunderstorms in the afternoon.

g. If a sea breeze is in effect and thunderstorms have remained west of the river at sunset, watch for the thunderstorms to move across the river if the sea breeze breaks down.

h. Persistence based on movement during the last 24 hours will serve well in forecasting easterly wave movement. A 2 knot decrease in movement should be made west of 70°W.

MISCELLANEOUS

a. In doubtful situations, forecast scattered low and high clouds and visibility greater than 7 miles.

b. If the 5,280 meter height contour at 500 mb (on prog charts) is north of Patrick, the cold front will either not move through or there will be a very weak frontal passage.

c. A surface high pressure cell in the Gulf indicates a long period of good weather.

HOMESTEAD AFB (HST) FORECAST GUIDE

1. UNITS SUPPORTED: TFW (F-4), ADC FIS (F-106), ARRS (UH-1), AEW&C (EC-121), AFRES AARS (UH-1, HH-3, CH-3), Army Support (UH-1, U-8).

2. PHYSICAL DESCRIPTION AND LOCATION: Homestead Air Force Base is located in extreme southern Florida 15 miles south-southwest of the Miami area. The southern tip of Florida is mostly swamp. Everglades National Park lies west and south-west, and areas to the north are partially inhabited. Home-stead lies a few miles in from the Atlantic. Field elevation is 7 feet, and the runway is oriented 05-23.

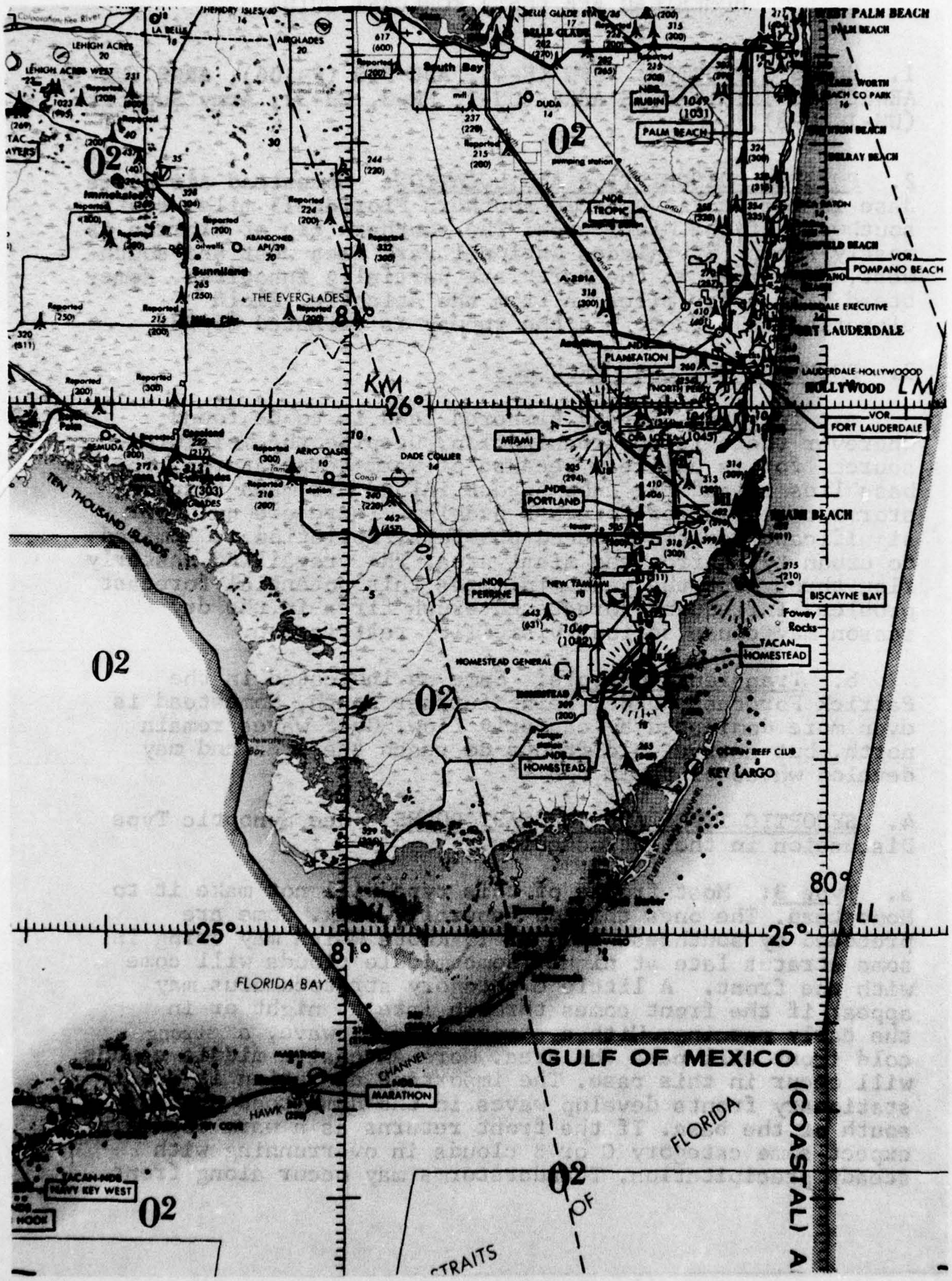
3. PECULIAR FORECAST PROBLEMS:

a. Terrain: Marshy timbered land is to be found wherever there is no urbanization. Despite the moisture source, fog is unlikely because of warm temperatures. The base lies inland far enough that inland air mass thunder-storms are a summer forecast problem. There are no other significant terrain-induced problems. Pollution is limited to urban types from the Miami area. The prevailing easterly flow throughout the year minimizes this potential forecast problem. Infrequent forest and brush fires in the dry season may cause serious visibility restriction.

b. Transient Controls: Same as indicated in the Patrick Forecast Guide. Being further south, Homestead is even more dominated by easterly flow. Gulf waves remain north, but active cold fronts do reach the area and may develop waves of their own.

4. SYNOPTIC TYPES AND FORECAST RULES: See Synoptic Type Discussion in the Introduction.

a. Type B: Most fronts of this type will not make it to Homestead. The ones that do generally weak. Some are preceded by southwest flow to 15 knots which may bring in some stratus late at night. Some middle clouds will come with the front. A little C category stratocumulus may appear if the front comes through late at night or in the early morning. With a strong type B_1 wave, a strong cold front will pass the area. More extensive middle clouds will occur in this case. The important exception is quasi-stationary fronts develop waves in the Homestead area or south of the base. If the front returns as a warm boundary, expect some category C or B clouds in overrunning with steady precipitation. Thunderstorms may occur along front.



WEST PALM BEACH
PALM BEACH
LAKE WORTH
BELLE GLADE
South Bay
RUBIN
TROPIC
LEHIGH ACRES
Sunniland
THE EVERGLADES
POMPANO BEACH
FORT LAUDERDALE
PLANTATION
HOLLYWOOD
FORT LAUDERDALE
MIAMI
PORTLAND
DADE COLLIER
AERO OASIS
MIAMI BEACH
PERRINE
NEW TAMIAMI
BISCAYNE BAY
Fowey Rocks
HOMESTEAD
HOMESTEAD GENERAL
OCEAN REEF CLUB
KEY LARGO
TEN THOUSAND ISLANDS
FLORIDA BAY
GULF OF MEXICO
MARATHON
NAVY KEY WEST
STRAITS OF FLORIDA
(COASTAL)
26°
25°
81°
80°
0²
KM
LM
LL

b. Type E: The cold front of the Texas low brings a significantly cold air mass to the HST area. As far as clouds are concerned, consider category D stratocumulus and middle clouds. Showers and thundershowers are also possible. Behind the front, category C clouds will persist at night but will probably scattered in the daytime. Northwest winds will be briefly gusty out of the northwest at 25 knots. Post-frontal radiation fog is possible with light winds and clear skies.

c. Type B, Summer: Easterly winds prevail all day gusting at most to 15-20 knots in the early afternoon. Isolated thunderstorms form inland but usually stay away from HST. Late night buildups offshore may produce showers at sunrise. In general, late night buildups offshore may produce showers at sunrise. Ceilings are uncommon, but this discussion does not consider tropical activity.

5. SEASONAL FORECAST RULES: In winter, fog is rare when temperatures are 70°F. or more. Dewpoints should be above 60°F. Fog does not seem to form when surface winds are north through southeast and also if over 5 knots. Visibility in fog is usually category C.

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